GREAT LAKES BINATIONAL TOXICS STRATEGY

MANAGEMENT ASSESSMENT FOR DIOXINS

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&

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DISCLAIMER:

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EXECUTIVE SUMMARY

INTRODUCTION

The Great Lakes Binational Toxics Strategy identifies specific challenge goals for each Level 1 substance for the US and Canada, with a timeframe that expires in 2006. As 2006 approaches, an analysis of progress and determination of next steps is needed to respond to the mandate set forth in the Strategy. A *General Framework to Assess Management of GLBTS Level 1 Substances* was developed to provide a tool to assist the Parties (Environment Canada and USEPA) and stakeholders in conducting a transparent process to determine the appropriate management outcomes for the Level 1 substances. This report presents an analysis of dioxins and furans conducted using the general framework.

CHALLENGE GOAL STATUS

Canada has achieved an 87% reduction in dioxin releases compared to the challenge goal of 90%. Based on current initiatives underway or proposed for dioxins, Canada will continue to work toward this challenge goal within the Great Lakes Basin. Total annual dioxin releases from inventory sources in Ontario are currently estimated at 35 g TEQ.

The US is confident that it has met the challenge goal of a 75% reduction in dioxin releases. Because the US challenge goal baseline is defined in terms of the USEPA Dioxin Reassessment which is currently undergoing review by the National Academy of Sciences, formal conformation of the challenge goal achievement will have to wait until the release of the final reassessment. The EPA draft reassessment estimates emissions for the years 1987 and 1995. In May of 2005, EPA released a draft inventory for the year 2000. This new draft inventory, which is awaiting peer review, estimates total dioxin emissions for 2000 to be approximately 1500 grams TEQ. This is a greater than 90% reduction over the draft 1987 baseline estimate.

ENVIRONMENTAL ANALYSIS

In general, there are sufficient data on the environmental presence of dioxins in multiple media to assess the impact of dioxins in the Basin. These include data in whole fish, fish tissue, herring gull eggs, sediment, water, air, human serum, and food. Current environmental and health criteria information, though limited, is sufficient to conclude that dioxins have a continued adverse impact on the Basin. For the criteria that exist, current data collected in the Great Lakes indicate exceedances of sediment and water quality guidelines, as well as dioxin contamination triggering fish consumption advisories in all Great Lakes. While more research is needed to determine the levels of dioxins in food that can be considered acceptable, the National Academy of Science has recommended steps be taken to further reduce exposure to dioxin in foods—the primary pathway of general population exposure (Institute of Medicine of the National Academies, 2003).

Long-term temporal trend information is not available for dioxin/furan levels in open water, fish tissue, US ambient air, and the commercial food supply. A long-term downward trend in dioxin/furan levels appears to be evident in US sediment cores, Great Lakes herring gull eggs, Canadian ambient air, and average US human body burdens. Despite apparent long-term downward trends in dioxin levels in these measures of the environment and humans, current trends are less clear in other measured media (such as beef and dairy products). Overall, environmental levels of dioxins are extremely low, relative to most pollutants, but because of their extreme toxicity and ability to bioaccumulate, their risk potential is significant.

SOURCES OF DIOXIN

Dioxin releases to the Great Lakes environment occur from a wide variety of sources. With stringent controls in place on many of the previously dominant industrial and municipal sources, the largest remaining quantified source in both the US and Ontario is open burning of household waste. Other known sources include land application of sewage sludge, combustion and incineration, and metals smelting, refining, and processing. In addition to the inventoried sources of dioxin, a number of uncharacterized sources exist. The Dioxin Workgroup has begun to develop estimates for these uncharacterized sources, which include wildfires and prescribed burning, structural fires, and agricultural burning.

OPPORTUNITY ASSESSMENT

While significant reductions of dioxin releases have been achieved in both the US and Canada, additional opportunities for further GLBTS action can be identified, including:

- continuing efforts related to household garbage burning;
- coordinating with other GLBTS workgroups on common issues, such as residential wood burning and coplanar PCBs;
- monitoring implementation of USWAG/US EPA treated wood MOU;
- continuing to gather information on poorly characterized sources;
- exploring exposure pathway intervention; and
- working toward an integrated air monitoring network within the Great Lakes Basin.

However, it is important to consider: the effectiveness of pursuing further activities under the GLBTS, such as engaging interested stakeholders; the level of input expected from workgroup members; resource availability under the GLBTS to conduct studies and programs; status or strategy of the US and Canadian national dioxin programs; and value-added of GLBTS efforts to the national dioxin programs in both countries.

MANAGEMENT OUTCOME

The recommended management outcome for dioxins is to continue active Level 1 status. Maintaining the GLBTS Dioxin Workgroup would continue the momentum for reducing dioxin releases and for monitoring dioxin levels in the Great Lakes Basin. No lake-specific actions are required. Setting new quantitative challenge goals would be difficult for the remaining, largely non-point sources of dioxin. Rather than pursue a quantitative challenge goal, the Dioxin Workgroup may consider framing new qualitative challenge goals and examining possible numerical targets for specific sources. The greatest opportunity for the Dioxin Workgroup, through the Burn Barrel Subgroup, will be to continue its efforts to actively engage partners on the issue of household garbage burning and to educate public and local officials. The workgroup will also pursue the other opportunities identified for further GLBTS action. The workgroup will evaluate the need for a full workgroup versus a core group that oversees a few subgroups (e.g., focusing on pathway intervention, source characterization, uncontrolled combustion). The workgroup will also consider the need to engage new members, such as local government officials, and representatives from the fields of health and agriculture.

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ABBREVIATIONS

B(a)P	Benzo(a)pyrene
CAA	Clean Air Act
CCME	Canadian Council of Ministers of the Environment
CWS	Canada Wide Standards
D\F	Dioxins/Furans
EC	Environment Canada
EDC	Ethylene Dichloride
HCB	Hexachlorobenzene
FDA	Food and Drug Administration
GLBTS	Great Lakes Binational Toxics Strategy
GLFMP	Great Lakes Fish Monitoring Program
IADN	Integrated Atmospheric Deposition Network
I-TEQ_{DF}	International Toxicity Equivalence
MACT	Maximum Achievable Control Technology
MDL	Method Detection Limit
MOE	Ontario Ministry of the Environment
MOU	Memorandum of Understanding
MWC	Municipal Solid Waste Combustion
MWI	Medical Waste Incinerators
NAPS	National Air Pollution Surveillance Network
NARAP	North American Regional Action Plan
NHANES	National Health and Nutrition Examination Survey
NLFWA	National Listing of Fish and Wildlife Advisories
NPRI	National Pollutant Release Inventory
NSPS	New Source Performance Standard
OCS	Octachlorostyrene
PCBs	Polychlorinated Biphenyls
PCDD	Polychlorinated dibenzo-para-dioxins
PCDF	Polychlorinated dibenzofurans
PCP	Pentachlorophenol
PEL	Probable Effect Level
PMRA	Pest Management Regulatory Agency
POTWs	Publicly Owned Treatment Works
RCRA	Resource Conservation and Recovery Act
SOP	Strategic Options Process
TCDD	2,3,7,8-Tetrachlorodibenzo-p-dioxin
TCDF	2,3,7,8-Tetrachlorodibenzofuran
TEF	Toxicity Equivalence Factors
TEL	Threshold Effect Level
TEQ	Toxicity Equivalence
UNEP	United Nations Environment Program
USEPA	United States Environmental Protection Agency
USWAG	Utility Solid Waste Activities Group
VCM	Vinyl Chloride Monomer

DRAFT MANAGEMENT ASSESSMENT FOR DIOXINS

1.0 INTRODUCTION

The Great Lakes Binational Toxics Strategy (GLBTS or Strategy) identifies specific reduction challenges or goals for each Level 1 substance for the US and Canada. The time frame for achieving the Strategy's challenge goals expires in 2006. As 2006 approaches, an analysis of progress and determination of next steps is needed to respond to the mandate set forth in the Strategy. The *General Framework to Assess Management of GLBTS Level 1 Substances* was developed to provide a tool to assist the Parties (Environment Canada and USEPA) and stakeholders in conducting a transparent process to determine the appropriate management outcomes for the Level 1 substances: mercury, polychlorinated biphenyls (PCBs), dioxins and furans, hexachlorobenzene (HCB), benzo(a)pyrene (B(a)P), octachlorostyrene (OCS), alkyl-lead, and five cancelled pesticides: chlordane, aldrin/dieldrin, DDT, mirex, and toxaphene. The framework presents a logical flow diagram for evaluating progress and the need for further action by the GLBTS on the Level 1 substances. Further details on the background and objectives of the framework are provided in Appendix A.

This report discusses the analysis of dioxins and furans using the *General Framework to Assess Management of GLBTS Level 1 Substances.* While the framework's flow diagram guides the discussion, the primary intent of the analysis is to present an overall evaluation of the status of the substance with respect to:

- Progress toward the GLBTS challenge goals;
- Levels in the Great Lakes environment; and
- Future management of the substance within the GLBTS.

Dioxins (polychlorinated dibenzo-para-dioxins, or PCDDs) and furans (polychlorinated dibenzofurans, or PCDFs) are a group of toxic chemical compounds which are generated and released into the environment as by-products of various combustion and chemical processes. The aggregate of PCDDs and PCDFs are commonly and in this report referred to collectively as "dioxins." Due to their toxicity, tendency to bioaccumulate, and persistence in the environment, dioxins have been the subject of ongoing public health and environmental concern. Dioxins are distributed widely in the environment at levels which may pose risk. The following text from the National Academy of Sciences describes the known concern about human exposure to dioxin via the food supply.

> *Dioxins and chemically-related compounds… occur as widespread, low-level contaminants in animal feeds and the human food supply. Because dioxins accumulate in fatty tissue, consumption of animal fats is thought to be the primary pathway for human exposure. In humans, dioxins are metabolized slowly and accumulate in body fat over a lifetime. Dioxin toxicity and its human health impact have been the subjects of recent re-evaluations by the International Agency for Research on Cancer, the U.S. Agency for Toxic Substances and Disease Registry, the National Institute of Environmental Health Sciences, and the U.S Environmental Protection Agency (EPA). Data indicate declining levels of dioxin in the environment and in human tissues, although the assessments prepared by the agencies differ and have not yet be reconciled.*

> *Notwithstanding the declining overall levels, public concern about food safety issues such as endocrine disruptors in the food supply and the effect of dioxin-like compounds on children's health and development persists. Further, special populations that consume large amounts of fish and wildlife for cultural reasons (American Indian and Alaska Native tribes) and subsistence fishers have eating patterns that place them at higher risk for exposure levels that may be found to be dangerous* (Institute of Medicine of the National Academies, 2003).

Sampling results of various environmental media clearly show dioxin present in the Great Lakes Basin. Due to concerns that these levels may impact human health and wildlife, various local, state, regional, and national efforts, including the GLBTS, have focused on achieving further reductions in dioxin contamination.

Section 2.0 of the report documents progress toward achieving the Strategy's challenge goals. Section 3.0 evaluates the impact of the substance on the Great Lakes Basin using environmental and human health data. Section 4.0 evaluates the ability for the GLBTS to effect further reductions, and Section 5.0 arrives at a final management outcome for the GLBTS.

2.0 CHALLENGE GOAL STATUS

Have the challenge goals for the substance been met?

The GLBTS challenge goals for the US and Canada, as stated in the 1997 Great Lakes Binational Toxics Strategy agreement, are:

Canadian Challenge: Seek by 2000, a 90 percent reduction in releases of dioxins and furans from sources resulting from human activity in the Great Lakes Basin, consistent with the 1994 Canada-Ontario Agreement.

US Challenge: Seek by 2006, a 75 percent reduction in total releases of dioxins and furans (2,3,7,8-TCDD toxicity equivalents) from sources resulting from human activity. This challenge will apply to the aggregate of releases to the air nationwide and of releases to the water within the Great Lakes Basin.[1]

According to the most recent dioxin release data available (see Section 4 of this report), the US and Canada have both made significant progress toward reaching the dioxin/furan reduction goals outlined in the Strategy.

[1] Language in the Strategy states, "USEPA will use its September 1994 draft dioxin Reassessment as an interim baseline for calculating dioxin emission reductions. Once USEPA has completed and released its final dioxin Reassessment, it will use the Reassessment's emissions inventory for 1987 as the challenge baseline." [Available online: http://www.epa.gov/glnpo/p2/bns.html]

Ontario

Canada has made significant progress toward meeting the goal of a 90 percent reduction in releases of dioxins and furans, achieving an 87 percent reduction (227 grams) of total releases within the Great Lakes Basin, relative to the 1988 Canadian baseline. This reduction is based on the 2004 release inventory update for Ontario sources, which estimates a total annual dioxin/furan release of 35 grams. Much of the reductions achieved are attributable to the pulp and paper sector after federal regulations were impending or imposed, closure of hospital waste incinerators by the Ontario government (in anticipation of Ontario Regulation 323/02), and closure of an iron sinter plant and a municipal waste incinerator. Figure 1 illustrates reductions in the top Canadian (Ontario) dioxin/furan emission sources from 1997 and 2001. The figure also includes a forecast for 2005.

The renewed Canada-Ontario Agreement with Respect to the Great Lakes Basin Ecosystem commits to a 90 percent reduction in the release of dioxin/furans by the year 2005, from a baseline of 1988. Based on current initiatives underway or proposed for dioxins/furans, such as Canada-Wide Standards for waste incineration, iron sinter and electric arc furnaces, **it is expected that Canada will continue to work toward this commitment within the Great Lakes Basin**.

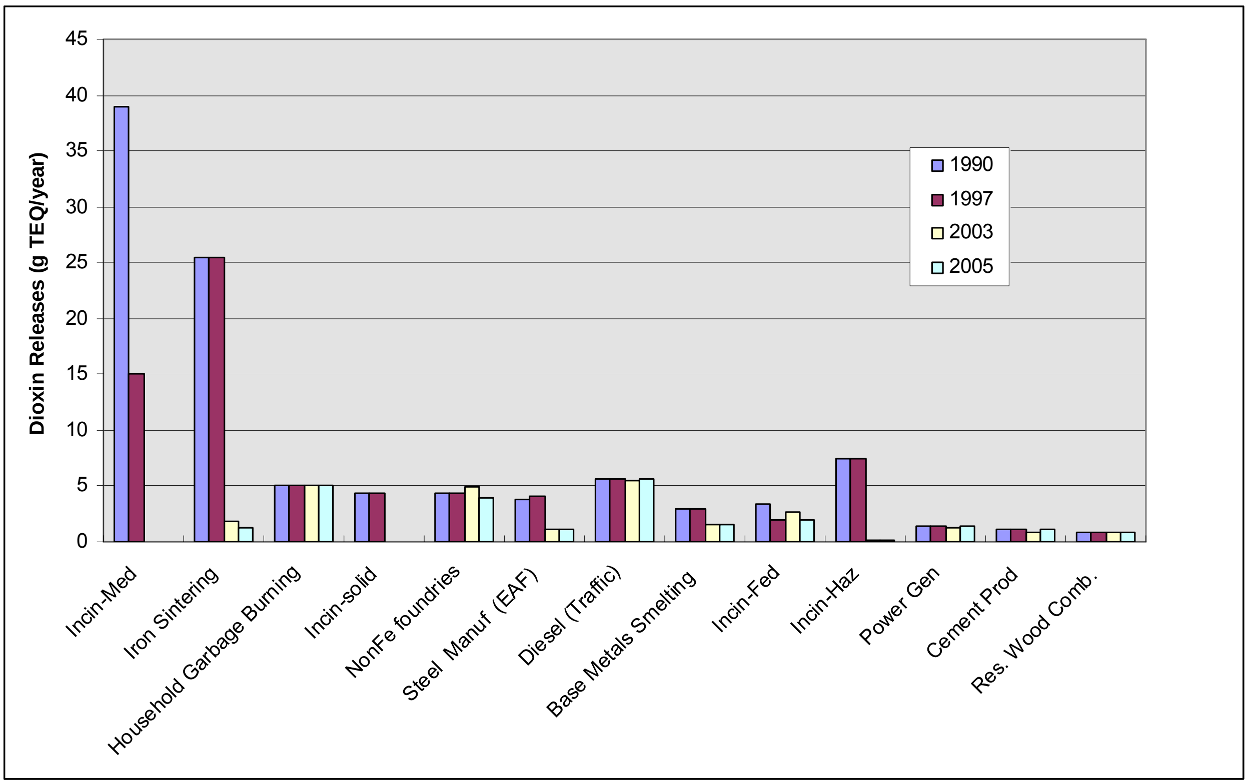


Figure 1. Top Canadian (Ontario Region) Dioxin/Furan Emission Sources. Source: Environment Canada, Ontario Region. NOTE: For air releases, numbers for the baseline year of 1988 are the same as 1990. Pulp and paper releases are not shown, as this source contributed 146 grams at base-year and would have masked all other sectors on the graph.

United States

Significant reductions have been achieved in the US, primarily from the use of Maximum Achievable Control Technology (MACT) standards enacted under the Clean Air Act. For example, MACT standards are expected to achieve thousands of grams of reductions from large and medium size municipal waste incinerators; upon full implementation, the standards are estimated to reduce releases from this source category to approximately 12 g TEQ. Other source categories with significant reductions resulting from the enactment of MACT standards include Medical Waste Incinerators (MWIs), hazardous waste-burning cement kilns, and secondary copper smelting. These reductions result from a combination of change in processes and equipment to comply with standards, pre-existing actions in the design and retrofitting of facilities, and facility closures.

The baseline for the US challenge goal is defined in terms of the USEPA draft Dioxin Reassessment which is currently undergoing review by the National Academy of Sciences. USEPA is currently working on a 2000 Dioxin Inventory that is not part of the draft Dioxin Reassessment. The 2000 Dioxin Inventory indicates that major reductions have been achieved as the MACT program has been fully implemented. This inventory also estimates total dioxin emissions for 2000 to be approximately 1500 grams TEQ, a greater than 90 percent reduction over the draft 1987 baseline estimate. Once the draft Dioxin Reassessment is final, the US will be able to formally confirm achievement of the challenge goal.

However, the workgroup recognizes that a number of dioxin sources have not yet been quantified. All inventory efforts are limited by available data. There are sources of dioxin that still have inadequate data to support reasonable inventory estimates (e.g., forest fires, brush fires, agricultural burning, and certain metal smelting operations and ceramic manufacturing). Many of these sources are difficult to quantify. Acquiring data to characterize these sources remains a priority and long-term goal of the USEPA.

3.0 ENVIRONMENTAL ANALYSIS

The *General Framework to Assess Management of GLBTS Level 1 Substances,* described in Section 1.0, calls for an analysis to consider Canadian and US environmental monitoring data and established human health or ecological criteria as the primary basis for an objective evaluation of whether dioxins impose a negative impact on the Great Lakes Basin. Efforts were made to identify basin-specific measures in air, water, sediment, fish, wildlife, food, and human biological samples. In some cases, national data are presented. Considering that the US challenge goal applies to air releases nationwide, a broader scope of measures may be acceptable for assessing the impacts of dioxins on the Great Lakes Basin. In addition, because of the highly distributed nature of commercial meat and dairy products, there is no clear geographical variation in exposure to dioxins through consumption of animal fats in the commercial food supply. Thus, in the absence of local data, national surveys of dioxin levels in the environment and the US food supply can provide valid information on the primary pathways of exposure to dioxins and other potential impacts in the Great Lakes Basin.

In interpreting environmental data on dioxins, it is important to note that different dioxin compounds have different toxicities, and dioxins are most often found in mixtures rather than as single compounds in the environment. One compound, 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) is the best studied, and one of the most toxic, of this class of compounds. TCDD is the reference compound for assignment of toxicity equivalence factors (TEFs) for related congeners. Scientists use a shorthand method for comparing the toxicity of different types or mixtures of dioxins to the toxicity of 2,3,7,8-TCDD. This method is called the "Toxicity Equivalence" or TEQ. Therefore, concentrations of dioxin and related compounds in biota and the environment are typically presented as 2,3,7,8-TCDD equivalents (TEQs). Although there are strengths as well as uncertainties involved in this approach, use of the TEQ approach is widely accepted in the international scientific community and is fundamental to the evaluation of this group of compounds (Ahlborg et al., 1994 and Van den Berg et al., 1998).

3.1 ENVIRONMENTAL AND HUMAN HEALTH DATA

Table 1 presents environmental and human health data that have been identified for purposes of assessing the likely impact of dioxins on the Great Lakes Basin. The table and ensuing discussion show that, in general, **there are sufficient data on the environmental presence of dioxins in multiple media** to assess the impact of dioxins in the Basin.

Table 1. Environmental and Human Health Data

DATA	RISK-BASED CRITERIA	EXCEEDANCES	TRENDS
Whole Fish			
USEPA Great Lakes Fish Monitoring Program, Basinwide monitoring in whole predator fish[1]	CFIA limit: 20 ng/kg TEQ[2]	None	Initially detected in late 1980s. Currently, rarely to never detected [3]
Fish Tissue (Filet)			
National Listing of Fish and Wildlife Advisories	USEPA guideline: 0.019 ng/kg TEQ (wet weight, for edible portion) CFIA limit: 20 ng/kg TEQ[2]	Advisories issued in each Great Lake and other Great Lakes waterbodies	N/A
US National Fish Tissue Study	See above	Study data not yet final. Detected at all first- & second-year sites in Great Lakes states[4]	No trend data available
Guide to Eating Ontario Sport Fish	Restrictions begin at 1.62 ppt, total restriction advised at >12.96 ppt	Restrictions for general pop. in Lakes Huron, Superior, Erie, and Ontario	No trend data available

DATA	RISK-BASED CRITERIA	EXCEEDANCES	TRENDS
Herring Gull Eggs			
Canadian Wildlife Service Herring Gull Egg Monitoring Program	None	N/A	Declining trends of 56%-75% in TCDD at Great Lakes sites (1984-2001)
Sediment			
Screening Level Survey of Sediment Quality in Tributaries to the Lower Great Lakes	0.85 CSQ TEL (ng/kg TEQ)	Exceedances at 85% of sites in Lake Ontario & 79% of sites in Lake Erie	No trend data available
	21.5 CSQ PEL (ng/kg TEQ)	Exceedances at 12% of sites in Lake Ontario & 11% of sites in Lake Erie	No trend data available
Sediment Contamination in the Great Lakes	See above	Exceedances at 58% of sites in Lake Ontario & 40% of sites in Lake Erie	No decline since early 1980s
Sediment Cores from 11 Lakes in the US	See above	N/A	Qualitative downward trend since 1960s-1970s
Biosolids			
Biosolids at Ontario STPs	Ontario interim std: 100 pg/g, dry wt	None	No trend data available
Open Water			
St. Clair-Detroit River Corridor Upstream/ Downstream Water Quality Monitoring [5]	MDEQ Water Quality Values: [6]		
	0.067 pg/L (HNV "drink" and "non-drink")		No trend data available
	0.0086 pg/L (HCV "drink" and "non-drink")	Detroit River Mouth, US side	No trend data available
	0.00319 pg/L (Wildlife Value)	All sites sampled	No trend data available
Ambient Air			
Canadian National Air Pollution Surveillance (NAPS) Network	MOE criterion:[7] 5 pg TEQ/m^3	None at Ontario sites	Decreasing TEQ concentrations from 1996 to 2002
US National Dioxin Air Monitoring Network (NDAMN)	See above	None at Great Lakes sites	Varying trends at Great Lakes sites
Precipitation			
Wet Deposition of PCDDs and PCDFs at Burlington, Ontario	Quality objective for dioxin deposition: 3.4-13.6 pg/m^2/day TEQ	None	No trend data available
Human Biomonitoring			
Health Canada data on human tissue levels	None	N/A	Levels of dioxin in Canadian serum and breast milk declined by 50% from the 1980s to the 1990s.[7]
US National Health and Nutrition Examination Survey (NHANES)	None	N/A	Lower levels in 1999-2000 compared to late 1980s
Food Supply			
Canadian Total Diet	WHO tolerable daily	N/A	No trend data available

DATA	RISK-BASED CRITERIA	EXCEEDANCES	TRENDS
Study	intake limit: 1-2 pg/kg body weight/day		
A Statistical Survey of Dioxin-Like Compounds in US Beef	None	N/A	No clear trend data available. National average in 1994: 0.89 ng/kg I-TEQ (lipid adjusted) [8]
A Statistical Survey of Dioxin-Like Compounds in US Pork Fat	None	N/A	Detectable decline from 1994 to 2001/02. National average in 1995: 1.3 ng/kg I-TEQ (lipid adjusted) [8]
A Statistical Survey of Dioxin-Like Compounds in US Poultry Fat	None	N/A	Detectable decline from 1994 to 2001/02. National average in 1996: 0.40-0.98 ng/kg I-TEQ (lipid adjusted) [8]
National Survey of Dioxin-Like Compounds in the US Milk Supply	None	N/A	No clear trend data available. National average in 1998: 0.82 ng/kg TEQ (lipid adjusted)

[1] Fish are not comparable between lakes due to differences in age and size.
[2] Limit for dioxins/furans in fish products and feeds (Seed, 2004).
[3] GLFMP consists of over 20 years of historical data.
[4] Using zero for non-detected analytes (Stahl, 2005).
[5] Whole-water samples collected from Environment Canada Water Quality Monitoring Stations along St. Clair and Detroit Rivers in 2002 and 2003.
[6] The Michigan (Rule 57) Water Quality values are the most sensitive available for water quality assessments. (Wildlife Value calculated only for Bioaccumulative Chemicals of Concern.)
[7] Seed (2004)
[8] When non-detects are set to ½ the detection limit.

Abbreviations used in the table:
CFIA – Canadian Food Inspection Agency
CSQ TEL – Canadian Sediment Quality Guidelines Threshold Effect Level
CSQ PEL – Canadian Sediment Quality Guidelines Probable Effect Level
HCV – Human cancer value (calculated only for carcinogens)
HNV – Human noncancer value
MDEQ – Michigan Department of Environmental Quality
MOE – Ontario Ministry of the Environment
N/A – Not applicable
STPs – Sewage treatment plants
WHO – World Health Organization

USEPA Great Lakes Fish Monitoring Program

PCDDs and PCDFs have been monitored sporadically in the USEPA Great Lakes Fish Monitoring Program (GLFMP), following the conclusion that the major source of PCDD/F in Great Lakes fish is from sediments. Because the program has been operating for over 20 years, several different analytical labs, principal investigators, and program officers have been involved in the program. In addition, advances in analytical technology have allowed for decreasing method detection limits (MDLs) over the course of the program. For dioxins and furans, the most recent samples are analyzed using GC/MS with an average MDL of 10 ng/g (Murphy, 2005).

Direct comparisons of contaminant concentrations across lakes are not possible with data from the GLFMP. Fish of a similar size are collected, rather than fish of a similar age. Because the age of the fish greatly affects bioaccumulation of contaminants, and because the length-age relationship varies from lake to lake, only general patterns can be observed. This is especially true for Lake Erie, where walleye are collected as the top predator fish rather than lake trout, which are collected in Lakes Superior, Ontario, Huron, and Michigan.

Analyses from this program have shown rare to no detection of PCDD/Fs in Great Lakes fish, in contrast to other monitoring data discussed below. Differences in waterbodies monitored, fish species collected, size/age of fish, fat content, and MDLs may contribute to these contrasting results.

US National Fish Tissue Study

The US National Study of Chemical Residues in Lake Fish Tissue (or the National Fish Tissue Study) is a four-year national screening-level freshwater fish contamination study. The National Fish Tissue Study measures dioxins/furans in predator and bottom-dwelling fish tissue from lakes and reservoirs of the continental US (excluding the Great Lakes). Dioxin/furan data include the 12 dioxin-like PCB congeners. Analysis of the data for all four years of the study is not complete, but USEPA is releasing interim raw data for each year as it becomes available. A final report is expected to be completed in 2006.

Data are currently available for the first two years of the study. The first- and second-year results consist of quality-assured raw data from analysis of fish samples collected during fall 1999 through 2001 (USEPA, 2004b). In the eight Great Lakes states, dioxins/furans/PCBs were detected at all 77 study sites sampled in the first two years of the National Fish Tissue Study with a maximum concentration of 0.05 μg/kg TEQ (Stahl, 2005). MDLs for dioxin/furan congeners analyzed ranged from 0.01 to 0.2 ng/kg (USEPA, 2004b).

The detection limits for the National Fish Tissue Study (0.00001 to 0.0002 ng/g) are over 10,000 times lower than the detection limits for the GLFMP (10 ng/g). (The National Fish Tissue Study has a larger sample collection than the GLFMP, allowing the detection limits to be decreased.) This may explain the difference in detection frequency between the GLFMP and the National Fish Tissue study.

National Listing of Fish and Wildlife Advisories

The National Listing of Fish and Wildlife Advisories (NLFWA) database includes all available information describing state-, tribal-, and federally-issued fish consumption advisories in the US for the 50 States, the District of Columbia, and four US territories, and in Canada for the 12 provinces and territories. The database contains information provided to USEPA by the States, Tribes, territories, and Canada. At present, the NLFWA contains advisories that were issued through December 2003. A query of the NLFWA database results in 29 fish advisories in the US and Canadian Great Lakes Basin for dioxins/furans (13 in Michigan, 4 in Wisconsin, and 12 in Ontario). This includes fish consumption advisories for each of the Great Lakes, as well as the Niagara River, St. Lawrence River, Wisconsin River, and numerous waterbodies in Michigan and Ontario (USEPA, 2004a).

Although dioxins are one of the five major contaminants that have resulted in the issuance of fish and wildlife consumption advisories, the geographic extent of dioxin advisories nationwide is extremely limited compared to that for the other four major contaminants (mercury, PCBs, chlordane, and DDT) (USEPA, 2004d). This is due in part to the high cost of chemical analysis which limits monitoring of dioxins and the fact that when there are multiple pollutants of concern, other pollutants such as mercury and total PCBs are less costly to monitor.

Guide to Eating Ontario Sport Fish

The *Guide to Eating Ontario Sport Fish* is published every other year by the Ontario MOE in co-operation with the Ministry of Natural Resources. Staff collect fish and send them to the MOE laboratory in Toronto. The fish are analyzed for a variety of substances, including dioxins. Recently, the Ontario MOE developed methods to analyze dioxin-like PCBs in fish. The results are used to develop the tables in the *Guide*, which give size-specific consumption advice for each species tested from each location. This advice is based on health protection guidelines developed by Health Canada (MOE, 2005). Data from this study are also provided to the US National Listing of Fish and Wildlife Advisories as described above.

Canadian Wildlife Service Great Lakes Herring Gull Eggs

The Canadian Wildlife Service (CWS) has analyzed temporal trends in contaminant levels in herring gull eggs from fifteen colony sites on the Great Lakes. Eggs have been collected from up to eight water bodies within the Great Lakes Basin: the St. Lawrence, Niagara, and Detroit Rivers and Lakes Ontario, Erie, Huron, Michigan, and Superior. Concentrations of 2,3,7,8-TCDD and 2,3,7,8-TCDF were first analyzed in 1984. The consistent monitoring of herring gull eggs by the CWS provides high-quality data with sufficient geographic coverage to assess the ecological impact of dioxins/furans in the Great Lakes.

An analysis of data collected from the CWS Herring Gull Egg Monitoring Program through 2001 is presented in the Great Lakes Binational Toxics Strategy 2002 Annual Progress Report (USEPA, 2002). Current concentrations (2001) of TCDD and TCDF in herring gull eggs on Great Lakes waterbodies and percent declines since 1984 are shown in Table 2. A calculation of TEQ values is not possible without concentrations of the other dioxin/furan congeners (not included in the Herring Gull Egg Monitoring Program). Current levels of TCDD in gull eggs in the Great Lakes Basin range from 4.16 to 19.80 ng/kg, with the highest levels reported at sites on Lake Ontario. A discussion of temporal trends in TCDD and TCDF levels in herring gull eggs is presented in Section 3.3.

Table 2. Concentrations of TCDD and TCDF in Herring Gull Eggs and Percent Decline from 1984 until 2001 on Great Lakes Waterbodies. Source: USEPA, 2002.

Water Body (N = number of sites)	2,3,7,8-TCDD (ng/kg)	Percent Decline	2,3,7,8-TCDF (ng/kg)	Percent Decline
Lake Ontario (N = 2)	19.80	75%	0.91	39%
St. Lawrence River (N = 1)	16.39	71%	0.32	68%
Niagara River (N = 1)	15.25	63%	0.32	84%
Lake Huron (N = 2)	8.71	70%	2.36	33%
Detroit River (N = 1)	8.65	74%	1.09	64%
Lake Superior (N = 2)	7.00	56%	0.21	95%
Lake Erie (N = 2)	6.88	69%	1.02	75%
Lake Michigan (N = 2)	4.16	72%	1.17	81%

Screening Level Survey of Sediment Quality in Tributaries to the Lower Great Lakes

Over the period 2001-2003, Environment Canada conducted screening level surveys of sediment quality in 101 Canadian tributaries to Lake Erie, including those into the St. Clair and Detroit River corridor and 211 Canadian tributaries to Lake Ontario, including the Niagara River and the St. Lawrence River. The purpose was to assess sediment quality in each tributary prior to discharge into their respective receiving waters. The study was designed to maximize the probability of detecting PCBs, organochlorine pesticides, polycyclic aromatic hydrocarbons (PAHs), and metals in these tributaries, rather than quantify contaminant loads. Results were compared to existing federal and provincial sediment quality guidelines (CCME, 1999; Persaud et al., 1993) to determine compliance. Results will also be compared to existing water quality, fisheries and benthic information, using a weight of evidence approach, to prioritize subsequent track-down efforts.

Information on the sediment quality of Canadian tributaries in the lower Great Lakes (Lakes Erie and Ontario) was summarized in Table 1. Dioxin data are limited to selected sites. A survey of tributaries draining to Lake Huron was scheduled for the fall of 2004. Results are not yet available.

Figure 2 provides information on the total TEQ values (dioxins, furans, and dioxin-like PCBs) relative to Canadian sediment quality guidelines for selected sites sampled as part of the screening level survey of sediment quality in tributaries to the lower Great Lakes. These sediment quality guidelines have been established for the protection of aquatic life. Concentrations were converted to toxic equivalents (TEQs) for comparison to sediment quality guidelines. The Lake Erie site with the greatest toxicity was Talfourd Creek with a value of 103 ng/kg TEQs. In Lake Ontario, Pringle Creek had the highest TEQ value of 92.7 ng/kg. The exceedences at these sites are approximately 4 ½ times greater than the Canadian sediment quality guidelines probable effect level (PEL) of 21.5 ng/kg TEQ (Waltho, 2004). A significant percentage of Lake Ontario and Lake Erie sites also exceed the threshold effect level (TEL) of 0.85 ng/kg TEQ.

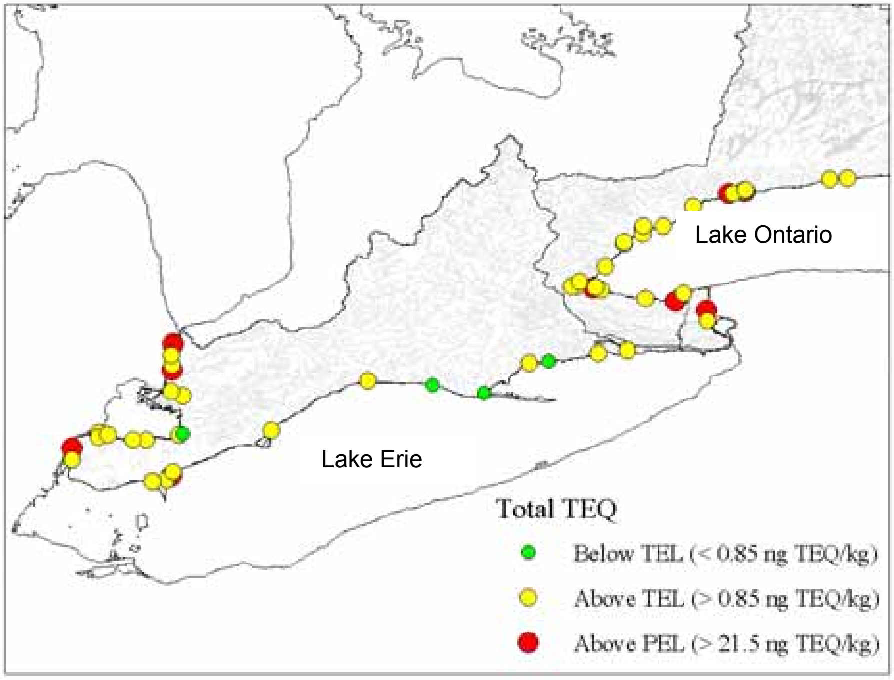


Figure 2. Total TEQs, including Dioxins, Furans and Dioxin-like PCBs from Screening Level Survey of Sediment Quality in Tributaries to the Lower Great Lakes. Source: Waltho, 2004.

Sediment Contamination in the Great Lakes

In 1997 and 1998, Environment Canada, in collaboration with other agencies, conducted sediment surveys in Lakes Erie and Ontario to assess sediment contamination relative to sediment quality and to compare contaminant concentrations with results of previous sediment surveys. Dramatic differences in sediment contamination between Lake Erie and Lake Ontario were discovered. The Lake Erie lakewide average for PCDDs and PCDFs was 18.8 pg/g and the 75^{th} percentile value was 33 pg/g TEQ (Marvin et al., 2002). The Lake Ontario lakewide average for PCDDs and PCDFs collected in the 1998 sediment survey was 111 pg/g TEQ and the 75^{th} percentile TEQ value was 183 pg/g (Marvin et al., 2003). Surficial sediment PCDD/PCDF concentrations at four stations in Lake Ontario exceeded 200 pg/g TEQ, representing a high degree of contamination and implicating potential sources along the Niagara River (Marvin et al., 2002).

Environment Canada has more recently collected dioxin/furan sediment data for Lakes Huron, Michigan, Superior, and St. Clair. Unpublished data for Lake Superior and Lake St. Clair show generally low levels of dioxins in Lake Superior and concentrations below 10 pg/g TEQ at all but one of 30 stations in Lake St. Clair (Marvin, 2004).

A Time-Trends Study of the Occurrences and Levels of CDDs, CDFs, and Dioxin-Like PCBs in Sediment Cores from 11 Geographically Distributed Lakes in the US

The USEPA and the US Department of Energy conducted a time trends study of dioxins, furans, and dioxin-like PCBs in sediment cores obtained from 11 freshwater lakes geographically distributed in the United States (Cleverly et al., 1996). This work was an expansion of the original study conducted by Dr. Ron Hites. Results show that, in general, dioxin and furan concentrations in the US began to rise in the 1930s and 1940s and began to decline in some lakes in the 1960s and 1970s. This decline is based on qualitative analyses only. Across all time periods, PCDD concentrations ranged from 10 ng/kg to 2,806 ng/kg in the 10 continental US lakes sampled. The national trend is similar to what has been seen earlier within the Basin.

Biosolids

The Ontario MOE commissioned a study to collect data from May 2001 to June 2002 on dioxin/furan concentrations in biosolids samples at sewage treatment plants (STPs) in southern Ontario and in the near North Ontario (Bonte-Gelok, 2005). The size of STPs studied range from large urban STPs to small rural STPs. The study included STPs with >20% industrial inputs to <1% industrial inputs. Table 3 presents data on dioxin/furan concentrations in biosolids at 25 Ontario STPs. The average concentration of dioxins/furans at 25 STPs sampled was 8 pg/g TEQ. The range of dioxin/furan concentrations in 61 samples collected was 2-16 pg/g TEQ. These levels are below Ontario’s interim standard for PCDD of 100 pg/g, dry wt (for paper biosolids to be land applied).

Table 3. Dioxin/Furan Concentrations in Biosolids at Ontario Sewage Treatment Plants.

Parameter	Dioxins/Furans (pg/g, dry wt, TEQ)
No. of STPs	25
No. of Biosolids samples	61
Median Concentration	7
Average Concentration	8
Standard Deviation	3
Min – Max Concentration	2 – 16

Source: Bonte-Gelok, 2005.

St. Clair-Detroit River Corridor – Upstream/Downstream Water Quality Monitoring

A discussion of the objectives and sampling strategy for a whole-water monitoring program initiated by Environment Canada in 2001 for the St. Clair and Detroit Rivers is provided in Appendix B. Whole-water samples collected from the St Clair-Detroit River corridor were subjected to a wide range of contaminant analyses that included dioxins and furans. Table 4 identifies exceedances of water quality criteria based on 2,3,7,8-TCDD mean concentration data collected from thirteen surveys conducted in the St. Clair-Detroit River Corridor in 2002 and 2003. Mean concentrations of 2,3,7,8-TCDD exceeded the Michigan wildlife (water quality) value at all sites, and the human cancer value at the Detroit River mouth site on the US side (Waltho, 2004). No guidelines exist for 2,3,7,8 TCDD in the Canadian Environmental Quality Guidelines - Water Quality for Aquatic Life (Canadian Council Ministers of Environment; CCME) or the Ontario Government Guidelines. For the St. Clair-Detroit River Corridor, Michigan Water Quality values are the most sensitive available for water quality assessments.

Table 4. Mean Concentrations of 2,3,7,8-TCDD and Exceedances of Michigan Water Quality Values based on Thirteen Surveys Conducted in St. Clair-Detroit River Corridor in 2002 and 2003. Source: Waltho, 2004.

Sampling Site	Mean 2,3,7,8-TCDD (pg/L)	MDEQ Water Quality Values (pg/L)				
		HNV drink: 0.067	HNV non-drink: 0.067	HCV drink: 0.0086	HCV non-drink: 0.0086	Wildlife Value 0.00319
St. Clair River						
Headwater	0.005					Exceeds
River Mouth US Side	0.008					Exceeds
River Mouth Can Side	0.005					Exceeds
Detroit River						
Headwater	0.005					Exceeds
River Mouth US Side	0.02			Exceeds	Exceeds	Exceeds
River Mouth Can Side	0.006					Exceeds

Abbreviations used in the table:
HCV – Human cancer value (calculated only for carcinogens)
HNV – Human noncancer value
MDEQ – Michigan Department of Environmental Quality
TCDD – Tetrachlorodibenzo-p-dioxin

The St. Clair-Detroit River Upstream/Downstream Water Quality Monitoring program includes extensive quality assurance/control procedures. Large volume samples are collected to achieve appropriate sensitivity. The analytical procedures incorporate clean techniques in combination with the most sensitive and selective instrumentation available. A comprehensive quality assurance program is in place with a large number of surrogate spikes employed to validate the data. The monitoring and analytical procedures are very consistent, and data are generated from one of the most competent labs in North America. Additional details of the sample collection and analysis procedures are provided in Appendix B.

Dioxin in Great Lakes Connecting Channels and Precipitation

Environment Canada monitors contaminants in Great Lakes interconnecting channels and precipitation. However, there are only a few limited dioxin analyses in water samples collected from the Great Lakes connecting channels. Two precipitation stations (Pt. Petre in Lake Ontario and Burnt Island in Lake Huron) began monthly dioxin measurement in rain samples. To date, the dioxin data are very preliminary and have yet to be validated.

Great Lakes Water Quality Surveillance Program

Dioxins/furans are not currently being monitored as part of the Great Lakes Water Quality Surveillance program conducted by Environment Canada on Lake Superior, Lake Huron/Georgian Bay, Lake Erie, and Lake Ontario. However, the need for dioxin/furan sampling of the open lakes has been recognized and sampling is planned for 2005, beginning with Lake Superior.

Canadian National Air Pollution Surveillance (NAPS) Network

As a component of the National Air Pollution Surveillance (NAPS) network, the Analysis and Air Quality Division of Environment Canada operates an ambient air measurement program for a number of compounds targeted in the Canada-Ontario Agreement (COA) respecting the Great Lakes basin ecosystem. PCDDs and PCDFs are among the COA substances monitored in this program. Appendix B provides a summary of the sampling and analytical methods, sampling sites, detection levels, and sampling frequencies for the COA substances sampling program.

Dioxins and furans were analyzed at 12 monitoring sites in Ontario during 1999-2003. PCDDs and PCDFs were detected in all samples collected. Table 5 presents median concentrations at each site from 1999 to 2003 for PCDD, PCDF, and total TEQ.

Table 5. Median Concentrations of Dioxins and Furans in Ambient Air at Ontario Sites, 1999-2003. Source: Environment Canada, 2004.

City	Address	TEQ[1] (fg/m^3)	PCDD (fg/m^3)	PCDF (fg/m^3)
Point Petre		10.1	268	113
Toronto	Junction Triangle	27.6	768	634
Toronto	Judson & Etona	23.6	643	429
Toronto	Evans & Arnold	20.4	765	496
Toronto	233 College St.	12.0	551	442
Egbert	CARE	18.3	314	156
Hamilton	Elgin & Kelly	34.0	1141	709
Hamilton	Hillyard St.	24.8	898	520
Hamilton	Confederation Park	41.4	1157	926
Simcoe	Experimental Farm	14.1	449	193
Windsor	College & South	31.2	1154	746
Burnt Island		4.72	126	103
Ratio of Medians[2]		8.8	8.2	4.0
Frequency of Detect		100%	100%	100%
Maximum Concentration[3]		765	22203	14533

[1] 2,3,7,8-TCDD toxic equivalents; non-detects set to the detection limit
[2] Ratio of highest to lowest site median
[3] For all sites and sampling days

Concentrations were higher at urban sites than at rural sites. The highest TEQ value from 1999 to 2003 (765 fg/m^3) was recorded in Hamilton at the Confederation Park site. Median TEQ concentrations ranged from 4.7 fg/m^3 at the Burnt Island site (2 samples only) to 41.4 fg/m^3 at the Hamilton – Confederation Park site (when non-detects were set to the detection limit). The 2,3,7,8-TCDD congener was detected in 39% of samples.

US National Dioxin Air Monitoring Network (NDAMN)

Atmospheric concentrations of dioxins, furans, and coplanar PCBs were collected in the National Dioxin Air Monitoring Network (NDAMN) from 1998 until 2004. The USEPA established NDAMN as a long-term data collection effort to determine the temporal and geographical variability of atmospheric dioxins, furans, and dioxin-like PCBs at rural and remote locations throughout the US. NDAMN data from 1998 through 2001 have been verified by quality assurance and quality control procedures. Figure 3 presents average total TEQ concentrations collected at NDAMN sites in 2000. (The numbers in the figure refer to the location of NDAMN stations, rather than dioxin concentrations.) These data suggest that atmospheric dioxin concentrations at some Great Lakes sites are higher than in other parts of the country. This may be a reflection of population density and/or the impact of proximate sources.

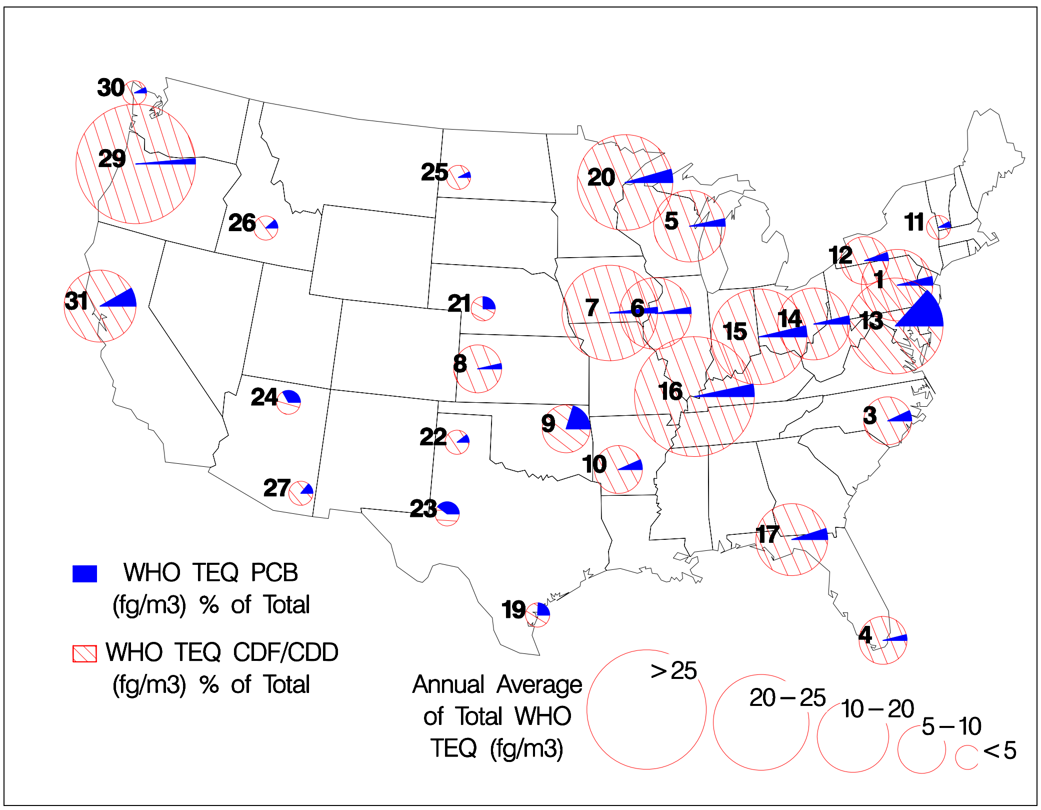


Figure 3. Average Atmospheric Concentrations of Dioxin TEQ (PCDDs, PCDFs, and Coplanar PCBs) in femtograms (10-15 grams) per cubic meter for the Year 2000. Collected by the National Dioxin Air Monitoring Network (NDAMN). The numbers in the figure refer to the NDAMN station location. Source: USEPA.

Figure 4 presents average total TEQ concentrations from 1998 to 2001 for seven sites (and one duplicate analysis) in the Great Lakes. These data indicate no clear trend of decline or increase over the sample period, only variability from year to year.

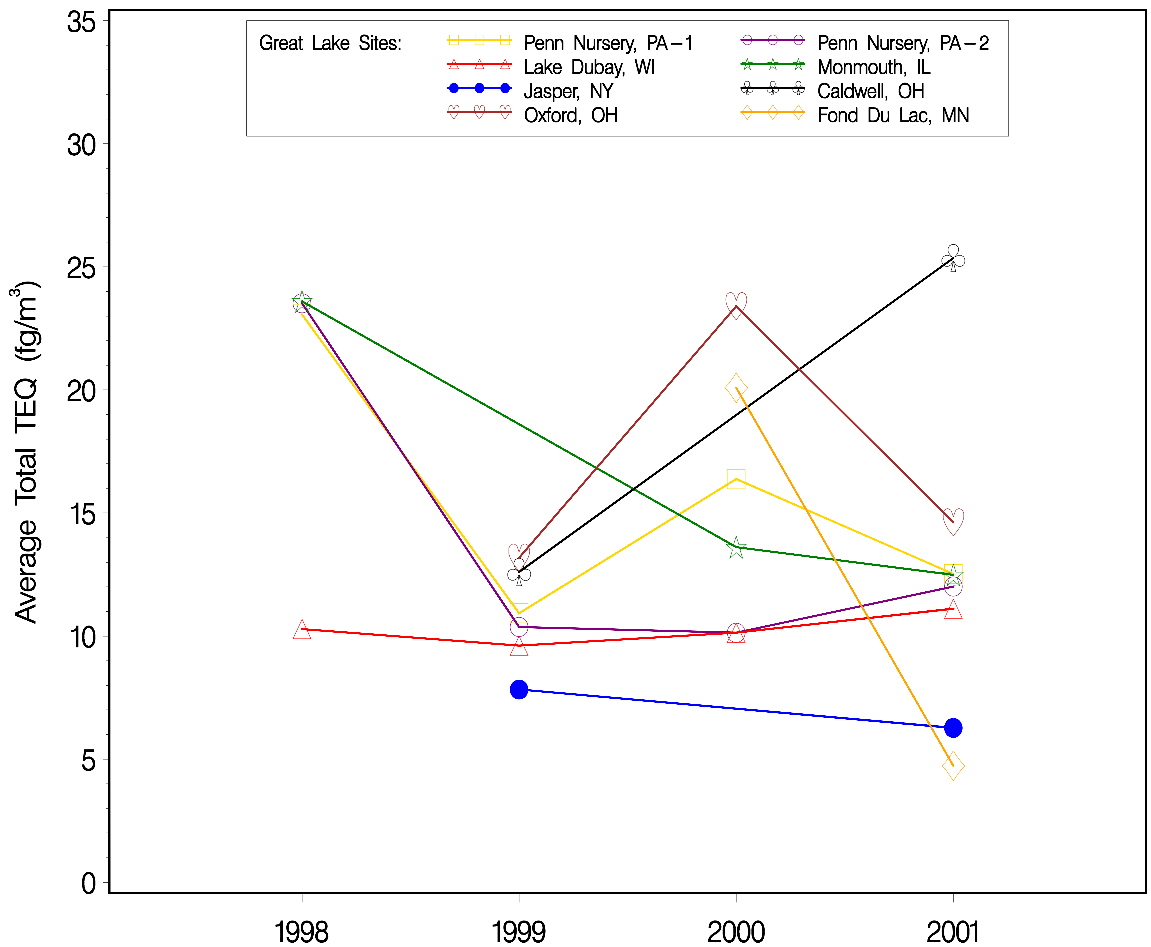


Figure 4. NDAMN Average Total TEQ Concentrations, including Dioxins, Furans, and Dioxin-like PCBs, for Great Lakes Sites, 1998-2001. Source: USEPA.

Figure 5 illustrates the seasonal variation in average total TEQ concentrations collected at NDAMN sites in the Great Lakes from 1999 to 2001. Concentrations in the fall are slightly higher than concentrations in the other seasons. The data were categorized into winter, spring, summer, and fall using the season assignments provided in the Final NDAMN 2000 Annual Report (USEPA, 2003). For these data, fall consists of sampling moments collected in Nov/Dec; winter consists of moments collected in Jan/Feb; spring consists of moments collected in Mar/Apr, Apr/May, and May/Jun; and summer consists of moments collected in Jun/Jul, Jul/Aug, and Aug/Sep. (Each sampling moment consists of 20 or 24 days of sampling over a 28-day period.)

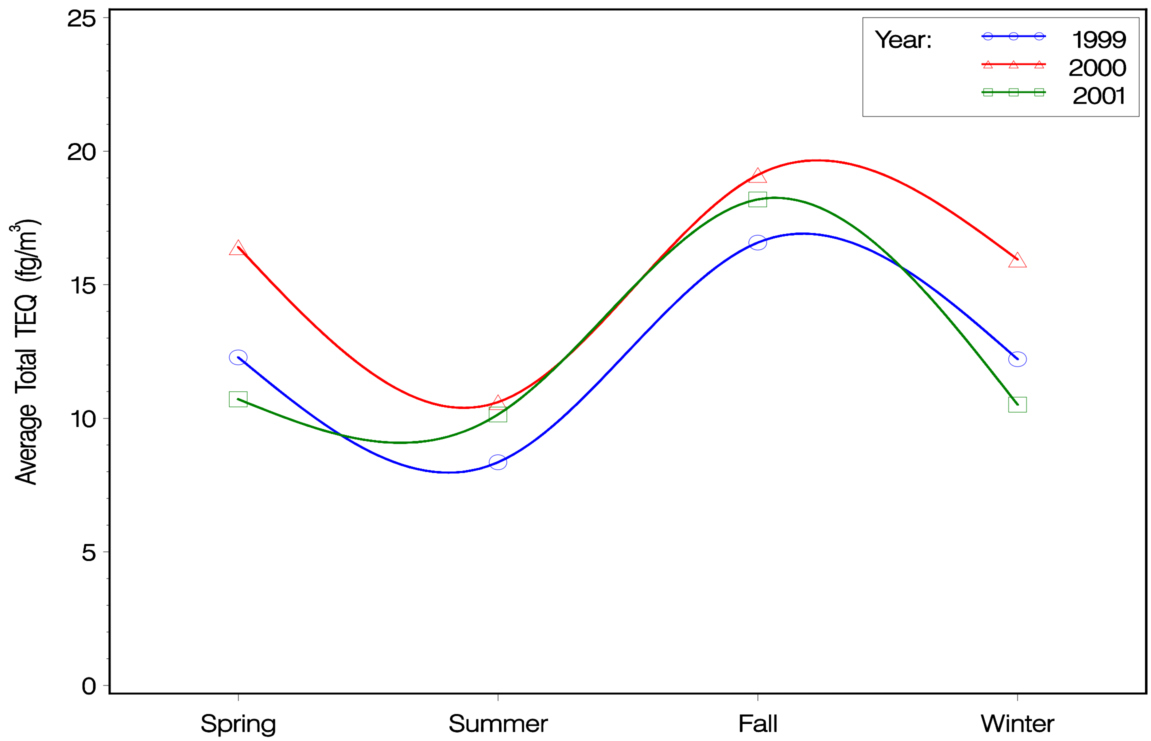


Figure 5. Seasonal Variation in NDAMN Average Total TEQ Concentrations at Great Lakes Sites, 1999-2001**.**

Integrated Atmospheric Deposition Network (IADN)

Monitoring of dioxins in the Integrated Atmospheric Deposition Network (IADN) was scheduled to begin in the fall of 2004. IADN was established by the US and Canada to conduct air and precipitation monitoring for a number of contaminants in the Great Lakes Basin.

In 2003, Environment Canada conducted a study of dioxins/furans in wet deposition at the Burlington, Ontario, IADN site (Backus, et al., 2004). This site is influenced by industries in Hamilton and an adjacent major highway. The mean value of PCDD/PCDF fluxes measured in wet deposition at Burlington was 0.62 pg/m^2/day TEQ, with little variation in monthly samples collected from June to November 2003.

National Health and Nutrition Examination Survey (NHANES)

Dioxin/furan concentrations in the US population are currently being measured by the Centers for Disease Control and Prevention (CDC) in the National Health and Nutrition Examination Survey (NHANES). NHANES provides an ongoing assessment of the US population's exposure to environmental chemicals by measuring chemicals or their metabolites in human specimens such as blood or urine. The CDC issued the first *National Report on Human Exposure to Environmental Chemicals* in March 2001, which presented exposure data for 27 chemicals from NHANES 1999. The CDC released the *Second National Report on Human Exposure to Environmental Chemicals* in January 2003, which presents biomonitoring exposure data for 116 environmental chemicals (including the 27 in the first report) from NHANES over the 2-year period 1999 to 2000. The *Third National Report on Human Exposure to Environmental Chemicals* was released in July 2005, with updated information on chemicals included in the second report, as well as new data on additional chemicals.

Dioxins, furans, and coplanar PCBs are included in the later two reports, but were not included in the first report. The second report presents serum lipid-based measurements of dioxins, furans, and coplanar PCBs measured in a subsample of NHANES 1999-2000 participants aged 12 years and older (CDC, 2003). The subsample was randomly selected to be representative of the US population. Results are presented by individual compound for six PCDDs, nine PCDFs, and three coplanar PCBs. For individual samples, TEQ was not evaluated due to low serum volumes. Consequently, comparisons of the data from 1999-2000 to 2001-2002 were not made by the CDC. More information on the NHANES study is available on line at www.cdc.gov/exposurereport.

Canadian Total Diet Study

Since 1969, Health Canada has conducted Total Diet Studies, also known as Market Basket Surveys/Studies, for accurate estimates of dietary intakes of contaminants. To date, Total Diet Studies have been conducted in the following five time periods to estimate the levels of chemicals to which Canadians in different age-sex groups are exposed through the food supply:

1) 1969 – 1973
2) 1976 – 1978
3) 1985 – 1988
4) 1992 – 1999
5) Presently being conducted (began in 2000).

Each Total Diet Study is conducted in several major Canadian cities over the time period, normally one city each year. More information about the methods of sample collection and analysis can be found at http://www.hc-sc.gc.ca/food-aliment/cs-ipc/fr-ra/e_tds.html.

Data on dioxin food concentrations and dietary intakes are available for five cities surveyed between 1992 and 1995 in the Canadian Total Diet Study. For example, in 1992, Health Canada measured TEQ concentrations in fatty food and dietary intakes of dioxin-like chemicals for different age-sex groups for the Toronto Total Diet Study. The average total dietary TEQ intake for all age groups from these five cities was 1.1 pg/kg body weight/day. Dietary TEQ intake levels for infants less than one year of age are 2-7 times greater than the average intake for all age groups (Health Canada, 2004).

Health Canada Data on Human Tissue Levels

Canada is conducting a nationwide survey to measure dioxins in maternal and fetal cord blood (Seed, 2004). Although the most recent data are not yet available, earlier data indicate:

- Levels of dioxins in Canadian serum and breast milk declined by 50% from the 1980s to the 1990s;
- Pooled Canadian breast milk samples indicated dioxin levels of 40.7 pg TEQ/g lipid in 1981 vs. 19.9 pg TEQ/g lipid in 1992;

- Canadian human tissue levels are approximately 2-fold lower than those of most European countries.

A Statistical Survey of Dioxin-Like Compounds in United States Beef

In 1994, the US Department of Agriculture and the USEPA undertook a joint effort to survey the occurrence and concentrations of dioxins and furans in the fat of beef animals raised for consumption in the US (Winters et al., 1996). The statistically designed national survey sampled beef animals (bulls, steers, heifers, beef cows, and dairy cows) from federally inspected slaughter establishments in the US. State-of-the-art laboratory procedures were used to quantify dioxins and furans, analytical protocols were fully validated prior to sample analysis, and appropriate quality control/assurance procedures were followed throughout the study. The results, published in the peer-reviewed literature and displayed in Table 6, showed a mean concentration of 0.35 ng/kg I-TEQ (lipid adjusted) when non-detects are set to a value of zero, and a mean concentration of 0.89 ng/kg I-TEQ (lipid adjusted) when non-detects are set to ½ the detection limit. The rate of detection of 2,3,7,8-TCDD was 16 percent. Winters et al. (1996) note that the survey results may not be fully representative of dioxin/furan levels in beef products that are purchased or consumed due to commercial operations such as packaging and processing or consumer practices such as trimming and cooking.

A subsequent survey conducted in 2002-03 by the US Department of Agriculture using similar protocols to the 1994 survey (Huwe et al., 2004). The later survey (Table 7) showed a reduction in the mean level of dioxin in beef when non-detects were set at ½ the detection limit and an increase when non-detects were set at zero. When the 1996 and 2001-02 surveys are compared, the improved (lower) detection limits in the later survey can account for the differences between the two studies. Consequently, there is no clear change in levels of dioxins in beef between the two studies.

A Statistical Survey of Dioxin-Like Compounds in United States Pork Fat

In 1995, the US Department of Agriculture and the USEPA undertook a joint effort to survey the occurrence and concentrations of dioxins, furans, and coplanar PCBs in the belly fat of pork animals in the US (Lorber et al., 1997). The statistically designed national survey sampled swine (market hogs, sows, and boars) from federally inspected slaughter establishments in the US. The sample analysis procedures followed were very similar to those used in the survey of US beef fat (above). The results, published in the peer-reviewed literature and displayed in Table 6, showed an overall dioxin/furan mean concentration of 0.46 ng/kg I-TEQ (lipid adjusted) when non-detects are set to a value of zero, and a mean dioxin/furan concentration of 1.3 ng/kg I-TEQ (lipid adjusted) when non-detects are set to ½ the detection limit. The presence of 2,3,7,8-TCDD occurred in 3 of 78 samples (4 percent). As with beef, the US Department of Agriculture conducted a more recent survey in 2002-03 (Table 7). In the case of pork, the declines seen in the results are not explainable by the detection limits and therefore appear to show an actual decline in dioxin levels.

A Statistical Survey of Dioxin-Like Compounds in United States Poultry Fat

In 1996, the US Department of Agriculture and the USEPA undertook a joint effort to survey the occurrence and concentrations of dioxins, furans, and coplanar PCBs in the abdominal fat of poultry animals in the US (Ferrario et al., 1997). The statistically designed national survey sampled poultry (young chickens, light fowl, heavy fowl, and young turkeys) from federally inspected slaughter establishments in the US. The sample analysis procedures followed were similar to those used to analyze for dioxins/furans in the survey of US beef fat (above). Results are published in the peer-reviewed literature and displayed in Table 6. Excluding two samples with significantly elevated dioxin concentrations, the mean dioxin/furan concentrations for 78 poultry samples ranged from 0.40 to 0.98 ng/kg I-TEQ (lipid adjusted) for the four classes of poultry, when non-detects are set to ½ the detection limit. The dioxin/furan TEQ concentrations reported for poultry in this survey are comparable to concentrations of these compounds reported in beef and pork in similar surveys (see above). As with beef, the US Department of Agriculture conducted a more recent survey in 2002-03 (Table 7). Similar to the pork survey, the declines seen in the results are not explainable by the detection limits and therefore appear to show an actual decline in dioxin levels.

Table 6. Average levels of seventeen PCDD/Fs, three co-planar PCBs, and TEQs in the US food supply in method blanks, by class. Blanks and detection limits (DL) were converted to pg/g lipid (ppt) using the average lipid percent value from the survey. Sample levels are reported in pg/g lipid (ppt) with nd=DL/2 and nd=0 in parentheses. Detection limits are calculated as the mean levels in the blanks + 2 x standard deviations (95% confidence level). Also noted are sample size and year of sample collection.

Congener	Beef n=63 1994	Market Hogs n=80 1995	Young Chickens n=39 1996	Turkeys n=15 1996
2378-TCDD	0.05 (0.03)	0.10 (0.01)	0.16 (0.15)	0.24 (0.24)
12378-PeCDD	0.35 (0.04)	0.45 (0.01)	0.24 (0.12)	0.32 (0.23)
123478-HxCDD	0.64 (0.18)	0.52 (0.10)	0.18 (0.05)	0.16 (0.03)
123678-HxCDD	1.42 (1.21)	1.10 (0.80)	0.39 (0.33)	0.79 (0.77)
123789-HxCDD	0.53 (0.26)	0.47 (0.04)	0.39 (0.29)	0.17 (0.06)
1234678-HpCDD	4.48 (4.39)	10.15 (9.93)	1.53 (1.53)	0.54 (0.52)
OCDD	4.87 (3.26)	52.77 (52.40)	5.31 (5.31)	0.75 (0.68)
2378-TCDF	0.03 (0)	0.09 (0.0004)	0.28 (0.28)	0.57 (0.57)
12378-PeCDF	0.31 (0)	0.45 (0)	0.21 (0.08)	0.36 (0.25)
23478-PeCDF	0.36 (0.06)	0.56 (0.14)	0.25 (0.12)	0.53 (0.47)
123478-HxCDF	0.55 (0.27)	0.98 (0.60)	0.23 (0.10)	0.20 (0.13)
123678-HxCDF	0.40 (0.12)	0.58 (0.58)	0.20 (0.07)	0.17 (0.03)
234678-HxCDF	0.39 (0.10)	0.57 (0.16)	0.21 (0.08)	0.15 (0.03)
123789-HxCDF	0.31 (0)	0.45 (0)	0.15 (0)	0.15 (0)
1234678-HpCDF	1.00 (0.75)	3.56 (3.35)	0.27 (0.20)	0.15 (0.02)
1234789-HpCDF	0.31 (0)	0.57 (0.17)	0.17 (0.04)	0.15 (0)
OCDF	1.88 (0)	2.30 (1.85)	0.34 (0.07)	0.29 (0)
PCB-77	-	1.57 (0.41)	9.3	5.6

Congener	Beef n=63 1994	Market Hogs n=80 1995	Young Chickens n=39 1996	Turkeys n=15 1996
PCB-126	-	0.33 (0.20)	1.8	4.4
PCB-169	-	0.26 (0.19)	0.2	0.6
TEQ D/F	-	-	0.64 (0.41)	0.93 (0.76)
TEQ PCB	-	-	0.28 (0.28)	0.66

Table 7. Average levels of seventeen PCDD/Fs, three co-planar PCBs, and TEQs in the US food supply in method blanks, by class. Blanks and detection limits (DL) were converted to pg/g lipid (ppt) using the average lipid percent value from the survey. Sample levels are reported in pg/g lipid (ppt) with nd=DL/2 and nd=0 in parentheses. Detection limits are calculated as the mean levels in the blanks + 2 x standard deviations (95% confidence level). Also noted are sample size and years of sample collection. Source: Huwe et al., 2004.

Congener	Blanks/DL n=33	Beef n=139 2002-03	Market Hogs n=136 2002-03	Young Chickens n=151 2002-03	Turkeys n=84 2002-03
2378-TCDD	0.00/0.07	0.06 (0.04)	0.04 (0.00)	0.04 (0.01)	0.06 (0.03)
12378-PeCDD	0.00/0.04	0.24 (0.24)	0.04 (0.02)	0.0 (0.05)	0.17 (0.17)
123478-HxCDD	0.00/0.04	0.31 (0.31)	0.08 (0.07)	0.05 (0.04)	0.10 (0.10)
123678-HxCDD	0.01/0.04	1.64 (1.64)	0.20 (0.20)	0.27 (0.27)	0.38 (0.38)
123789-HxCDD	0.01/0.05	0.33 (0.32)	0.04 (0.01)	0.06 (0.05)	0.05 (0.03)
1234678-HpCDD	0.14/0.27	4.16 (4.16)	1.42 (1.40)	1.40 (1.39)	0.36 (0.31)
OCDD	1.12/3.14	7.02 (6.12)	13.77 (12.80)	6.37 (5.47)	3.77 (2.51)
2378-TCDF	0.02/0.06	0.04 (0.01)	0.04 (0.01)	0.08 (0.07)	0.18 (0.18)
12378-PeCDF	0.02/0.04	0.03 (0.01)	0.03 (0.01)	0.07 (0.06)	0.11 (0.10)
23478-PeCDF	0.04/0.08	0.20 (0.20)	0.12 (0.09)	0.09 (0.07)	0.20 (0.20)
123478-HxCDF	0.05/0.13	0.47 (0.46)	0.21 (0.17)	0.12 (0.07)	0.13 (0.10)
123678-HxCDF	0.05/0.15	0.30 (0.26)	0.16 (0.09)	0.11 (0.05)	0.11 (0.05)
234678-HxCDF	0.02/0.04	0.24 (0.24)	0.09 (0.08)	0.06 (0.05)	0.05 (0.05)
123789-HxCDF	0.00/0.05	0.03 (0.00)	0.03 (0.00)	0.03 (0.00)	0.02 (0.00)
1234678-HpCDF	0.10/0.30	0.91 (0.84)	0.77 (0.66)	0.27 (0.15)	0.17 (0.04)
1234789-HpCDF	0.01/0.03	0.05 (0.04)	0.06 (0.04)	0.02 (0.01)	0.02 (0.00)
OCDF	0.07/0.17	0.31 (0.25)	0.71 (0.64)	0.24 (0.18)	0.23 (0.16)
PCB-77	6.74/12.68	7.95 (2.61)	9.21 (4.16)	9.59 (5.01)	7.91 (3.21)
PCB-126	0.10/0.18	1.34 (1.34)	0.31 (0.26)	0.78 (0.78)	1.79 (1.79)
PCB-169	0.00/0.12	0.32 (0.32)	0.30 (0.28)	0.39 (0.37)	0.79 (0.79)
TEQ D/F	0.04/0.21	0.79 (0.75)	0.24 (0.16)	0.25 (0.18)	0.45 (0.41)
TEQ PCB	0.01/0.02	0.14 (0.14)	0.04 (0.03)	0.08 (0.08)	0.19 (0.19)
Total TEQ	**0.05/0.23**	**0.93 (0.89)**	**0.28 (0.19)**	**0.33 (0.26)**	**0.64 (0.59)**
TEQ Range	**0.01–0.10**	**0.21–6.12 (0.13–6.12)**	**0.11–4.50 (0.00–4.50)**	**0.13–1.90 (0.03–1.86)**	**0.16–1.88 (0.06–1.88)**

National Survey of Dioxin-Like Compounds in the United States Milk Supply

The USEPA conducted a survey in 1996-1997 to provide a non-statistical estimate of the average concentrations of dioxins, furans, and coplanar PCBs in the general pasteurized milk supply of the US (Lorber et al., 1998). Composite samples were collected from USEPA's Environmental Radiation Ambient Monitoring System sampling stations over four time periods of a year. The sample analysis procedures followed were similar to those used to analyze for dioxins/furans in the beef, pork, and poultry surveys (above). Results are published in the peer-reviewed literature and displayed in Table 8. The national average of PCDD/PCDF TEQ concentrations in milk in 1996-1997 was 0.78 pg/g lipid.

Table 8. US temporal and geographical variation of CDD/CDF milk concentrations (pg TEQ/g lipid) in 1996-97 in the United States. Source: Lorber, 1998.

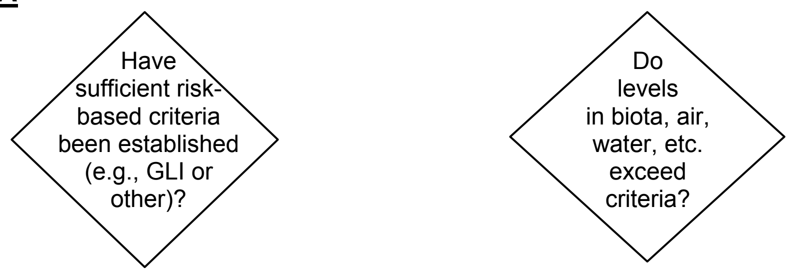
Composite Location	April 1996	July 1996	October 1996	January 1997	Average
Northeast	0.94	0.67	0.91	0.79	0.82
Southeast	1.32	0.88	1.64	0.81	1.13
Midwest	Not Available	0.74	0.92	0.91	0.87
Southwest	0.36	0.25	0.64	0.79	0.51
Northwest	0.32	Not Available	0.87	1.23	0.80
National Average	0.74	0.64	1.00	0.92	**0.78**

The USEPA conducted a more recent national milk survey in 2000-2001 using similar protocols to the 1996-1997 survey. The national average of PCDD/PCDF TEQ concentrations in milk in 2000-2001 was 0.71 pg/g lipid, indicating no clear change in dioxin levels in the US milk supply.

Table 9. US temporal and geographical variation of CDD/CDF milk concentrations (pg TEQ/g lipid) in 2000-2001. Source: Schuda, 2004.

Composite Location	July 2000	January 2001
New England	0.46	0.35
Mid-Atlantic	0.45	0.67
South Central	0.76	0.77
North Central	0.81	0.66
West Central	0.67	0.72
Southwest	0.50	0.21
Far South	0.69	1.28
Far West	1.07	0.46
Composite Mean	0.88	0.54
National Average		**0.71**

3.2 CRITERIA



Current criteria information is sufficient to conclude that dioxins have a continued adverse impact on the Basin. Criteria have not been developed to assess environmental levels of dioxins in all media. For the criteria that do exist, current data collected in the Great Lakes indicate exceedances of sediment and water quality guidelines, as well as dioxin contamination triggering fish consumption advisories in all Great Lakes. A discussion of current criteria information for various media is presented below.

Whole Fish

The Canadian Food Inspection Agency has set a limit of 20 ng/kg TEQ for dioxins/furans in fish products and feeds. Recent measurements of PCDDs/PCDFs in whole top predator fish through the Great Lakes Fish Monitoring Program have resulted in rare to no detection, with decreasing detection limits (the current MDL for dioxins/furans is 10 ng/g) (Murphy, 2005).

Although there are discrepancies in dioxin levels reported by the GLFMP and other fish monitoring programs, these differences may be explained by differences in species of fish sampled, size/age or fat content of fish, and location of sample collection. Bioaccumulation of dioxins can vary by species, the age of fish affects bioaccumulation, dioxins tend to accumulate in fatty tissues, and local sources affect dioxin contamination of waterbodies. In addition, as stated earlier, all of these programs have varied detection limits which may explain the difference in detection frequency between the GLFMP and National/State fish monitoring programs. As a result, while the GLFMP reports rare to no detection of PCDDs/PCDFs in Lake Erie walleye, the Michigan Department of Community Health publishes fish consumption advisories for dioxins in carp, catfish, and whitefish caught from Lake Erie (MDCH, 2003).

Fish Tissue (Filet Samples)

The USEPA has developed guidance documents to help state, local, regional, and tribal environmental health officials who are responsible for developing and managing fish consumption advisories. In these documents, USEPA issued risk-based monthly fish consumption limit tables for various chemicals. For dioxins in the edible portion of fish, the carcinogenic health endpoint is 0.019 ng/kg TEQ (wet weight) (USEPA, 2004c). Fish consumption advisories issued for the Great Lakes through 2003 indicate potential health risks associated with consumption of fish from these waters. Fish consumption advisories for dioxins/furans have also been published by several Canadian provinces (Seed, 2004).

The Ontario *Guide to Eating Ontario's Sport Fish* is published bi-annually to provide guidance on interpretation of fish advisories monitored by the MOE (MOE, 2005). In Ontario, consumption restrictions for sport fish begin at levels of 1.62 ppt, with total restriction advised for levels above 12.96 ppt for toxicity equivalents of 2,3,7,8-TCDD. The 2005-2006 edition of Ontario's *Guide to Eating Ontario Sport Fish* summarizes the following percentages of fish consumption restrictions for the general population attributed to dioxin/furan contamination for the general population (i.e., relative to advisories due to other contaminants).

- Lake Superior: 65%
- Lake Huron: 50%
- Lake Erie: 19%
- Lake Ontario: 32%

Sediment

Two Canadian sediment quality benchmarks have been established as guidelines to assess potential risk and determine relative priorities for sediment quality concerns. The threshold effect level (TEL) indicates a concentration below which adverse biological effects are expected to occur rarely. The probable effect level (PEL) indicates a concentration above which adverse effects are expected to occur frequently. The TEL for dioxins is set at 0.85 pg/g TEQ. The PEL for dioxins is set at 21.5 pg/g TEQ. These Canadian sediment quality guidelines are considered a conservative approach to evaluating sediment quality (Marvin et al., 2003).

Exceedances of Canadian sediment quality guidelines are reported along tributaries to Lake Erie and Lake Ontario for selected sites sampled as part of the screening level survey of sediment quality in tributaries to the lower Great Lakes. Table 10 presents TEQ values for tributaries where the Canadian probable effect level (PEL) guideline was exceeded. The Lake Erie site with the greatest concentration was Talfourd Creek with a value of 103 ng/kg TEQ. In Lake Ontario, Pringle Creek had the highest TEQ value of 92.7 ng/kg. The exceedances at these sites are approximately 4 ½ times greater than the PEL of 21.5 ng/kg TEQ.

Table 10. Tributaries Showing Exceedances of the Canadian Sediment Quality Guidelines Probable Effect Level for Dioxins and Furans.

Lake Erie Tributaries	TEQ (ng/kg dw)	Lake Ontario Tributaries	TEQ (ng/kg dw)
Clay Creek	25.5	Aerocar Creek	22.0
Turkey Creek	86.5	Pioneer Creek	42.0
Talfourd Creek	103	Pringle Creek	92.7

dw = dry weight

Exceedances of the Canadian PEL (21.5 pg/g TEQ) for PCDD/PCDFs in surficial sediment were reported at 58 percent of the stations surveyed by Environment Canada in Lake Ontario in 1998. Exceedances of the Canadian PEL in Lake Erie occurred at a frequency of 40 percent (Marvin et al., 2002). The Lake Ontario lakewide average PCDD/PCDF value of 111 pg/g TEQ was approximately 5 times greater than the Canadian PEL (Marvin et al., 2003), while the Lake Erie lakewide average PCDD/PCDF value (18.8 pg/g TEQ) was just below the PEL (Marvin et al., 2002). Preliminary results of dioxin/furan sediment sampling conducted by Environment Canada in Lake Superior and Lake St. Clair report levels of dioxins below the Canadian PEL at all stations (Marvin, 2004).

Open Water

As discussed in Section 3.1, mean concentrations of 2,3,7,8-TCDD in whole-water samples from thirteen surveys conducted in the St. Clair-Detroit River Corridor in 2002 and 2003 exceeded the Michigan wildlife (water quality) value at all sites. The human cancer value of 0.0086 pg/L was also exceeded at the Detroit River mouth site on the US side. The Michigan water quality values are the most sensitive available for water quality assessments.

Water quality guidelines have been established to serve as yardsticks for many environmental and health issues. Exceedances of a particular guideline may not be sufficient to assess ecological or health impacts. Examination of other data sets more specifically related to ecology and health would be required in the case of 2,3,7,8-TCDD in the lower Detroit River (where the human cancer value was exceeded).

Ambient Air

The Ontario MOE has set a 24-hour ambient air quality limit for chlorinated dibenzo-p-dioxins of 5 pg TEQ/m^3 (equivalent to 5,000 femtograms (fg) TEQ/m^3) (Seed, 2004). Median TEQ concentrations measured in ambient air at Ontario sites from 1999 to 2003 (see Table 5), as well as average TEQ levels at Great Lakes NDAMN sites (see Figure 4), are well below this criterion.

Data collected from NDAMN and other studies have shown that atmospheric concentrations of dioxins/furans in urban areas can be on the order of 10 to 100 times greater than concentrations in rural or remote areas (USEPA, 2003).

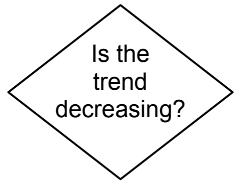
Human Biomonitoring

Body burden estimates are the best method of describing human exposure and are usually derived from serum levels. Results of studies indicate that in both countries, dioxin levels in human tissues have declined from the 1980s. However, body burdens are a function of long term exposure and may not reflect current exposure levels. Several agencies such as the World Health Organization (WHO), the Agency for Toxic Substances and Disease Registry, and Health Canada have established various types of intake-exposure risk criteria, but body burden criteria have not been developed.

Food Supply

Neither the US FDA nor Health Canada have established intervention levels for dioxins in food, but Health Canada has adopted the WHO tolerable daily intake limit of 1-2 pg/kg body weight/day (Seed, 2004). The average total dietary TEQ intake collected as part of the Canadian Total Diet Study from 1992 to 1995 (1.1 pg/kg body weight/day) exceeds the lower limit of the WHO tolerable daily intake level for dioxin exposure. The European Union has proposed maximum limits as well as action and target levels for dioxin TEQ in food and feedstuffs (EU, 2001). These limits vary by type of food product. Levels of dioxins in foods sold in Canada, and for which the European Union has proposed maximum limits for dioxin TEQ, are generally below the proposed maximum limits (there were instances where a sample did exceed the proposed maximum limits) (Seed, 2004).

3.3 TRENDS



Data on environmental trends is fairly limited since methods to measure dioxin at the levels it exists in the environment were not available until the 1980s. However, there is enough data to show that there has been a significant decline in environmental levels since the late 1960s and early 1970s. Data to support this includes dioxin levels in US sediment cores, which show a gradual increase until the late 1960s and then a downward trend into the 1980s. This data also supports the conclusion that current dioxin levels are primarily the result of anthropogenic sources, as there is no other plausible explanation for the historical increase and decrease measured in dioxin levels in the environment. More recent data indicate that the trend in sediment cores is consistent with declines in other media. Great Lakes herring gull egg data indicate a similar downward trend.

In addition, while a declining trend cannot be shown in (whole) Great Lakes fish, the rare instances of detection in recent years, compared to detections in the late 1980s at higher method detection limits (see Section 3.1), would seem to indicate that dioxin/furan levels have fallen over the past 20 years. This downward trend is consistent with the declining emissions in the US and Canada reported in Section 2.0.

Long-term temporal trend information is not available for dioxin/furan levels in open water, fish tissue, and the commercial food supply. A recent decline has been observed in dioxin levels in pork and poultry from the US commercial food supply, while the trend in dioxin levels in beef and dairy is the subject of ongoing analyses to determine, among other things, the appropriate way to account for non-detects in the analysis.

A discussion of trend information in various media is presented below.

National Listing of Fish and Wildlife Advisories

The NLFWA database revealed 29 fish advisories in the US and Canadian Great Lakes Basin for dioxin. This includes fish consumption advisories for each of the Great Lakes, as well as the Niagara River, St. Lawrence River, Wisconsin River, and numerous waterbodies in Michigan and Ontario (USEPA, 2004a). Due to an increase in the number of assessments of fish and wildlife tissues, and the increasing use of fish advisories, trends in the number of fish consumption advisories issued may not accurately reflect changes in levels of fish contamination.

Sediment Cores

Based on a study of sediment cores from 11 geographically distributed lakes in the US, a downward trend in dioxin/furan concentrations since the 1960s and 1970s has been observed qualitatively (Cleverly et al., 1996). Further analyses would be needed to confirm this observation quantitatively and to investigate temporal trends specifically in the Great Lakes.

Temporal trends in PCDDs and PCDFs in Lake Ontario sediment were analyzed from a core taken from the Mississauga Basin (Marvin et al., 2002). Levels of PCDD/PCDFs decreased to approximately 100 pg/g TEQ between 1970 and 1980, and levels do not appear to have decreased since that time. The highest levels of contamination—contamination of approximately 300 pg/g TEQ—corresponded to the period of roughly 1950-1970.

Great Lakes Herring Gull Eggs

For the period 1984 to 2001, TCDD levels declined by 56 percent to 75 percent, and TCDF levels declined by 33 percent to 95 percent (see Table 2), at herring gull egg colonies on the Great Lakes (USEPA, 2002). Results of a statistical change-point regression analysis of the 1984-2001 dioxin/furan herring gull egg data, performed by the Canadian Wildlife Service, indicate no significant trend in TCDD concentrations at 6 of the 15 colony sites (40 percent), significantly declining trends at 6 of the 15 sites (40 percent), and increasing TCDD levels after a change point at 3 of the 15 sites (20 percent). Results of the change-point regression analysis for TCDF show no significant trend in TCDF concentrations at 5 of 15 sites (33.3 percent), significantly declining concentrations at 5 of 15 sites (33.3 percent), and increasing TCDF levels after a change point at 5 of 15 sites (33.3 percent).

Ambient Air

Trends in ambient air concentrations of dioxins collected by Environment Canada were examined for the period 1996-2002. Figure 6 presents trends in median annual TEQ concentrations at sites reporting data for at least four years. The following criteria were required for a complete dataset at a given site for each year: a valid month of data, defined as consisting of a minimum of one sample per month; a valid quarter consisting of two valid months per quarter; and a valid year consisting of four valid quarters. Thus, each year of data in Figure 6 represents at least eight samples. Non-detectable TEQ concentrations were assigned values equal to the detection limit. Regression analyses were performed to determine if the changes in concentrations with time were statistically significant.

Median annual TEQ concentrations were higher at urban sites than at rural sites. TEQ levels decreased significantly from 1996 to 2002 at the Toronto – Junction Triangle site, Hamilton – Elgin & Kelly site, and Windsor site. The apparent decreases in TEQ concentrations at rural sites (Point Petre and Simcoe) were the result of improvements in the detection limit. When non-detects were set to zero, the decreases in TEQ concentrations at these rural sites were not significant (Environment Canada, 2004).

While NDAMN data collected from 1998 to 2001 are available, it is difficult to determine trends in the data. For example, Figure 4 shows varying trends in ambient background levels (not associated with any known local sources) of dioxin-like compounds in air at Great Lakes sites, from NDAMN data collected during 1998-2001. Concentrations in year 2000 tend to be higher than in years 1999 and 2001, which might be due to a number of unexplained factors (e.g., temperature, wind speed). Additional years of data are needed to reach firm conclusions about trends in dioxin levels since the network began monitoring in 1998.

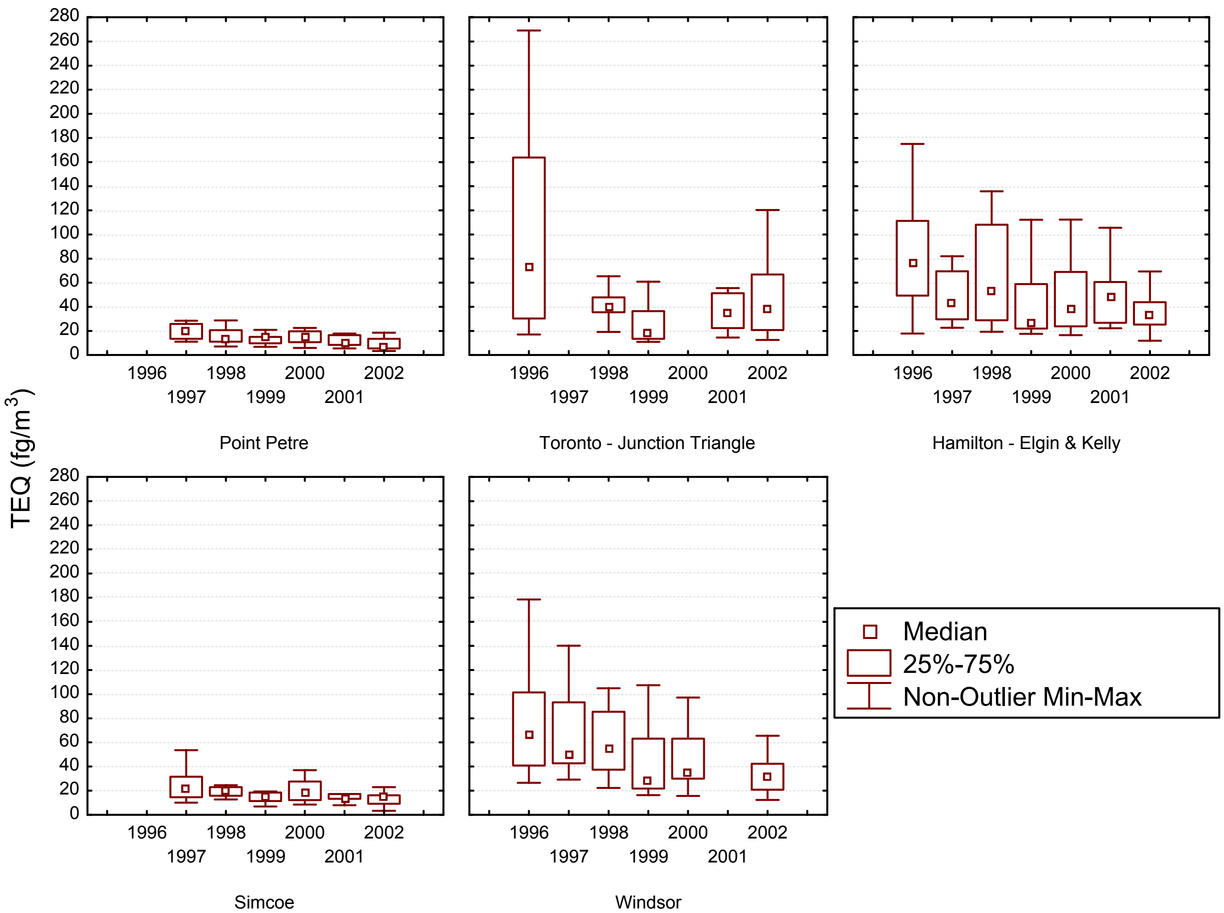


Figure 6. Trends in Median Annual TEQ Concentrations in Ambient Air at Ontario Sites, 1996-2002. Source: Environment Canada.

Human Body Burdens

The average dioxin tissue level for the general adult US population has declined over the past thirty years. In the US in the late 1980s, body burdens associated with average background exposure to dioxins, furans, and dioxin-like PCBs ranged from 30 to 80 ng/kg TEQ (lipid basis). In NHANES 1999-2000, median concentrations of dioxins, furans, and coplanar PCBs measured in the serum of participants aged 12 years and older were below the level of detection (CDC, 2003).

3.4 ENVIRONMENTAL ANALYSIS CONCLUSIONS

Levels of dioxin and dioxin-like compounds in the environment have declined over the past thirty years. A long-term historic downward trend is evident in US and Great Lakes sediment cores. Trends are tied to sediment layers as newer layers are less contaminated than older layers. There is uncertainty as to whether older layers of sediments contribute to exposure due to resuspension of contaminated sediment. Dioxin/furan levels in Great Lakes herring gull eggs also showed a declining trend, although the majority of the decline occurred early on; shorter term trends in the 1990s into the turn of the century have been less clear. Long-term temporal trend information is not available for dioxin/furan levels in open water, fish tissue, and the commercial food supply.

Exposure to dioxin-like compounds has also decreased over the past thirty years. Average US human body burdens appear to have declined. However, the exposure reduction is not uniform across all pathways. Despite apparent long-term downward trends in dioxin levels in the environment and humans and significant reductions in emissions, current trends in some environmental media (such as ambient air) and in certain foods (such as beef and milk) are less clear. Recent data on dioxin levels in food indicate a decrease in the mean levels in pork and poultry and no clear change in the mean levels in beef and milk. Meat, dairy and fish represent greater than 50 percent of the human dioxin exposure in the US. It is unclear how much exposure is driven by industry sources as opposed to uncontrolled burning and reservoir sources. However, there are still sources where further reductions can be achieved, and there is consistency among many science review panels (e.g., NAS, SAR) that it is still prudent to continue to look for ways to reduce exposure from all sources. Additionally, trend data for dioxins in various media are mixed, and current criteria information indicate that dioxins continue to have an impact on the Basin.

4.0 GLBTS MANAGEMENT ASSESSMENT

The key question to consider in the GLBTS management assessment of a Level 1 substance is whether the GLBTS can effect further reductions. To answer this question, this section briefly summarizes sources of dioxins, current regulations and programs, and reduction opportunities.

4.1 SOURCES

4.1.1 Current Known or Inventory Sources

The principal identified sources of environmental releases of dioxin and related compounds can be grouped into five main types:

- Combustion and Incineration Sources;
- Metals Smelting, Refining, and Processing;
- Chemical Manufacturing/Processing;
- Reservoir Sources; and
- Biological and Photochemical Processes.

In general, although dioxin/furan releases to the Great Lakes environment occur from a wide variety of sources, they are dominated by releases to the air from anthropogenic combustion sources. No large natural sources of dioxins/furans have been confirmed. At this time, household burning is currently recognized as the largest known source of dioxins/furans.

In the US, combustion sources such as large and medium Municipal Solid Waste Combustors (MWCs), MWIs, and hazardous waste cement kilns made significant reductions due to implementation of MACT rules.

Best estimates of known anthropogenic releases of dioxin and related compounds in Ontario are presented in Table 11 below. In addition to the inventory sources of dioxin listed in Table 11, tentative Ontario release estimates have recently been developed for wildfires and prescribed burning (111 g TEQ/year), structural fires (0.3 g TEQ/year), and agricultural burning (0.7 g TEQ/year) (Environmental Health Strategies, 2004a, 2004b, 2004c). A number of studies have been conducted that demonstrate the occurrence of dioxin/furan emissions from structure fires. In estimating emissions from structural fires, USEPA calculated an emission factor from the data presented by Carroll in 1996 and Thomas and Spiro in 1995. Also, according to Canadian national estimates developed by the Pest Management Regulatory Agency (PMRA) branch of Health Canada, 1.1 g TEQ of dioxins/furans are released to soil annually as a result of pest control product use, and 956 g of dioxins/furans are incorporated into wood preservation products (CCME, 2003). Note that the latter figure applies to dioxins/furans in wood preservation products, not in treated wood, and not necessarily released from wood products.

Reliability of Estimates. In general, the reliability of emission estimates for sources of dioxin vary for each source. The confidence in an emission estimate depends on the nature of the data used to calculate emissions.

Table 11. Current Known Anthropogenic Sources of Dioxins and Estimated Releases in Ontario. Source: Environment Canada 2004 Release Update.

Known Source [1]	**Percent Release Estimate (g/TEQ/year)**
Ontario Sources (2004 estimates)	
Open Burning Household Waste (Barrel Burning)	22% (7.6) [h]
Motor Vehicles	16% (5.6) [g]
Nonferrous Foundries (smelting, refining)	14% (4.9) [t, c]
Federal Waste (incineration)	8% (2.7) [a]
Sewage Sludge (land application)	8% (2.6) [a]
Iron Manufacturing (sintering)	5% (1.8) [c]
Mining & Smelting (base metal smelting)	5% (1.6) [c,r]
Thermal Power Generation (fossil fuel)	4% (1.3) [c,n]
Iron & Steel (electric arc furnaces)	3% (1.2) [c,s]
Waste Wood (steam plant)	3% (1.0) [f]
Municipal Solid Waste (landfill fires)	3% (1.0) [m]
Other [2]	11% (3.9) [a,b,c,e,i,j,k,l,r,u,v]
TOTAL	**100% (35.2)**

(1) Italics indicate releases to land. All other releases are to air, unless otherwise noted.

(2) In the Ontario inventory, “Other” includes sources whose emissions for any one source category do not exceed 1 g TEQ/year.

(a) [Environment Canada, 2001] Inventory of Releases of PCDDs and PCDFs, prepared by Environment Canada, February 2001 update
(b) Water release from [Environment Canada, 2001] inventory, see (a) above.
(c) NPRI (preliminary) 2003 releases
(d) TransAlt (Sarnia) gas fired cogeneration plant and TransCanada Energy (Stoddard Twp.) reporting 0 releases in 2003
(e) NPRI (preliminary) 2003 release for 1 facility; NPRI 2002 release for 1 facility not reporting in 2003
(f) NPRI 2001 release for waste wood fueled steam plant, not reporting in 2002 or 2003
(g) [Environment Canada, 2003] Toxics Emissions from On-Road Motor Vehicles in Ontario, draft report March 18, 2003, prepared by Toxic Prevention Division of Environment Canada, Ontario Region
(h) [Environment Canada, 2003] D/F release from open burning of household waste estimated for 2002 by Cindy Yang, Toxic Prevention Division of Environment Canada, Ontario Region. Emission factor and quantities of waste burned in 2000 from “Dioxin/Furan Emissions from On-site Residential Waste Combustion in Canada”, February 2003, prepared for CCME, by Gartner Lee Ltd.; 2002 waste quantities estimated using Statistics Canada population data.
(i) NPRI 2002 releases; no reported releases in 2003
(j) Waste wood combustion - Saw mills and pulp & paper mills
(k) Ontario regulation required all Ontario hospital incinerators approved prior to December 2002 to shutdown by December 6, 2003; Medical Waste Management (Brampton) reporting no release in 2003
(l) CCME Dioxins/Furans Status report February 2003: PMRA national estimate of 1.1001 g D/F predominately in soil from use of pest control products: PMRA national estimate of 956 g D/F in wood preservation products
(m) CCME 2003 Study (reported in GLBTS progress report February 2004) – estimated 1600 landfill sites in Ontario, 58% in Northern Ontario, of which 1% to 3% are burning waste. D/F release estimated at 0.5 to 1.5 g/yr based on USEPA emission factors.
(r) Three of 14 plants reporting 2003 releases
(s) Four of 6 mills reporting 2003 releases
(t) Five of 10 plants reporting 2003 releases
(u) Six of 7 plants reporting 2003 releases
(v) One vehicle parts manufacturer reporting a 2003 release

4.1.2 Poorly Characterized Sources

Initially dioxin emissions were thought to be only a problem stemming from chemical manufacturing. It was then discovered that combustion and incineration were also sources of dioxin. Knowledge about poorly characterized sources has continued to evolve. The US and Canada continue to investigate dioxin sources that have not yet been reliably quantified. Many of these sources are difficult to inventory, such as water releases, reservoir sources, and uncontrolled combustion sources, including forest fires. In addition, currently unsuspected sources may exist. The Dioxin Workgroup has identified the following list of poorly characterized sources. These are not yet fully quantified, although some may have preliminary estimates for either the US or Ontario side of the Great Lakes Basin.

<u>Industrial</u>

- Secondary metal smelting
- Coke production
- Ceramic manufacturing
- Clay processing
- Foundries
- Asphalt mixing
- Petroleum refineries
- Textile and leather dyeing
- Industrial Boilers

<u>Uncontrolled Combustion</u>

- Forest fires
- Brush fires
- Range fires
- Agricultural burning
- Landfill Fires
- Structural fires

<u>Other Combustion</u>

- Residential wood burning
- Crematoria
- Animal carcass
- Diesel vehicles (Off-road stationary and small trucks and buses)
- Boilers – Residential, Agriculture
- Copper wire recycling

<u>Municipal</u>

- Rural soil erosion
- Urban runoff
- Ash Disposal
- Landfill fugitive emissions
- Landfill fires

<u>Other</u>

- Utility poles and storage yards
- Transformer storage yards
- Pentachlorophenol (PCP) wood preservative

Reservoir Sources. Another poorly characterized category is reservoir sources. These are dioxins previously created and still residing in the soil, water, or air. The impact of these reservoir sources depends on their ability to either directly or indirectly contact humans and other environmental biota. However, it is clear these sources do exist and in some manner contribute to human exposure (Institute of Medicine of the National Academies, 2003).

4.2 <u>OPPORTUNITIES TO ACHIEVE FURTHER REDUCTIONS</u>

This section considers opportunities for the GLBTS to achieve further reductions of dioxins, where feasible. An important part of the assessment involves consideration of whether the identified reduction opportunities are significant enough to merit the effort. This section includes opportunities identified by the GLBTS Dioxin Workgroup in its workplan for 2003-2005 (finalized in December 2003).

4.2.1 Opportunities with Known or Inventory Sources

In the US, total annual dioxin releases from inventory sources are currently estimated at 1,100 g TEQ. The USEPA has pursued the control and management of dioxin releases through each of its major program areas (e.g., air, water); collectively, these actions place regulatory controls on all of the major well-defined industrial and municipal sources of dioxin in the US. Dioxin releases to air are controlled under regulations promulgated by USEPA under authority of the Clean Air Act (CAA) and its amendments, which require emissions limits for dioxins and other hazardous air pollutants based on "maximum achievable control technology" (MACT). With full implementation of the MACT rules, the major categories of commercial and municipal waste combustion are under direct regulation for their dioxin emissions. Dioxin releases to water are managed through a combination of risk-based and technology-based tools established under the Clean Water Act. Clean-up of dioxin-contaminated lands is an important part of the USEPA Superfund and RCRA Corrective Action programs.

In Ontario, total annual dioxin releases from inventory sources are currently estimated at about 35 g TEQ. A number of initiatives are in place to continue reductions of this release total even further. These include Canada-Wide Standards for waste incineration, iron sinter and electric arc furnaces, and a proposed Ontario initiative to phase out coal-fired power plants. Environment Canada will address remaining top sources in Ontario by following up on nonferrous foundries, federal waste incinerators, and sewage sludge land application. The base metal smelter sector is being managed through national initiatives which set guideline limits on dioxin/furan emissions.

Environment Canada is also continuing to characterize emissions of dioxins/furans and other toxic pollutants on poorly characterized sources through its voluntary stack testing program. Historical or reservoir sources of dioxins/furans need to be examined, and analyses may be conducted through existing programs that address sediment/soil contamination.

Table 12 summarizes current US and Canadian regulations and programs for known sources, and identifies opportunities for the GLBTS to achieve further reductions of dioxins.

Table 12. Reduction Opportunities for Sources of Dioxins. Source: Great Lakes Binational Toxics Strategy Draft Report for Internal Review, PCDD (Dioxins) and PCDF (Furans): Reduction Options. August 2000.

Source Category	Current US Regulations or Programs	Current Canadian Regulations or Programs	Opportunity for GLBTS to Achieve Further Reductions
Inventory Sources			
Household Waste Burning	Various programs and regulations at state, local, and tribal levels	National surveys conducted Educational initiatives to improve public awareness	Continue efforts of Burn Barrel Subgroup (see www.openburning.org) Develop case studies of alternatives to trash burning Develop a community peer mentoring system Meet with States and Tribes to promote projects and grants Support development of outreach materials
Sewage Sludge (incineration and land application)	In October 2003, EPA decided not to regulate dioxins in land applied sewage sludge under Biosolids Rule	CWS compliance beginning 2005 Studies being conducted	Investigate any localized issues
Residential Wood Burning	CAA air standards Certification / NSPS for particulate matter for stoves manufactured after 1990; Wood-stove change out programs	Environment Canada's 'Burn It Smart!' campaign and Residential Wood Combustion program Considering national regulation and/or CWS for PM/O3	Pursue joint efforts with B(a)P/HCB Workgroup
Coal-fired Utilities/ Oil-fired Utilities	Utilities exempt from sources that require MACT standards	Ontario passed regulation to cease coal-burning at one utility by April 2005 and plans to phase-out coal-burning at other Ontario utilities	
Motor vehicles (Unleaded/leaded/ diesel gasoline)	USEPA Region 5 program to retrofit diesel school buses & some heavy-duty trucks and locomotives	EC finalizing a draft motor vehicle emissions report (December 2004) Diesel retrofit pilot projects underway in SW Ontario	Pursue joint efforts with B(a)P/HCB Workgroup
Secondary Aluminum Smelting	Secondary Aluminum MACT rule (6/14/2002)	Need to examine issue in Ontario	[MACT rule probably sufficient – Approx. 45% of facilities subject to MACT rule located in Great Lakes states]
2,4-D (land application)	Safe drinking water standards for 2,4-D		Investigate annual application rates of 2,4-D in Great Lakes states
Iron Ore Sintering		CWS and SOP for Iron and Steel sector	
Industrial Wood Burning	MACT rule (2/26/2004)		

Source Category	Current US Regulations or Programs	Current Canadian Regulations or Programs	Opportunity for GLBTS to Achieve Further Reductions
Cement Kilns	CAA §112(c)(6): MACT air standards for hazardous waste combustors (64FR 52827); Portland Cement Kiln rule	CCME Federal-Provincial guideline for dioxin emissions	
EDC/Vinyl Chloride		CEPA Vinyl Chloride Release Regulations	
Municipal Solid Waste Combustion (MWC)	CAA §112(c)(6): MACT standards for MWC; No strict regulation of MWC ash	CWS for waste incineration; No strict regulation of MWC ash; EC study in 2003 concluded well-engineered sanitary landfills are safe disposal method	Follow-up on conclusions of 2003 EC study on dioxin in ash leachate from landfills; Investigate actual disposal practices in the Basin
Bleached Pulp & Paper Mills (water release)	Pulp & Paper Cluster Rule: Air and water standards for Pulp & Paper Source Category	Pulp and Paper Mill Effluent Chlorinated Dioxins and Furans Regulations, and Pulp and Paper Mill Defoamer and Wood Chip Regulations	
Crematoria			Determine number of sources located in the Basin and estimate emissions
Medical Waste Incineration (MWI)	CAA §112(c)(6): MACT air standards for MWI (62 FR 48347); No strict regulation of ash	CWS for waste incineration; Ontario phase-out of hospital incinerators; one commercial facility currently meets the CWS limit; no strict regulation of ash	
Nonferrous Foundries/Mining and Smelting	MACT rule (9/10/2003)	Stack tests conducted; Draft Code of Practice for Base Metal Smelters Canada to investigate dioxin emitting sources under NPRI	
Iron and Steel manufacturing (electric arc furnaces)	Current standards contain limits for organic hazardous air pollutants in total (mainly volatile pollutants), but not dioxins in particular (see FR, V. 69, No. 78, pp. 21905-21940). Also, most electric arc furnaces (EAFs) were not included in this MACT as EPA is apparently considering a separate area source MACT standard for these sources.	CWS and SOP for Iron and Steel sector	

Source Category	Current US Regulations or Programs	Current Canadian Regulations or Programs	Opportunity for GLBTS to Achieve Further Reductions
Landfill Fires		Burning of garbage at landfills banned; EC conducting study on open burning practices on First Nations lands in Ontario. 2003 CWS study on trench burning	Assist in information gathering efforts on First Nation lands
			Based on CWS study of trench burning, conduct outreach
Potential Sources			
Out-of-Service PCP Treated Wood	Used treated wood is either disposed of in accordance with applicable solid waste requirements, or managed as part of a secondary use market; USWAG has developed treated wood guidelines to support the sound management of treated wood products.	EC is finalizing a Users Guidance Document under SOP for treated wood	Monitor implementation of USWAG/EPA treated wood MOU.

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There remain opportunities for the GLBTS to pursue further reductions in sources of dioxins.

Household Waste Burning

Efforts related to household garbage burning, the largest known source of dioxins, present the greatest opportunity for continued GLBTS actions. The Dioxin Workgroup, through the Burn Barrel Subgroup, has been actively engaging partners on this issue to educate the public and local officials. The subgroup has developed a strategy that focuses on education, infrastructure, and enforcement. For several years, the subgroup has been successfully implementing this strategy through its website (www.openburning.org) and the active participation of its members. The GLBTS Dioxin Workgroup is pursuing other opportunities to increase awareness of the dangers of household garbage burning as well as efforts to reduce it.

Residential Wood Burning

Residential wood burning is an issue of concern for both the Dioxin Workgroup and B(a)P/HCB Workgroup. The Dioxin Workgroup aims to develop a plan to coordinate with other GLBTS workgroups on common issues. The B(a)P/HCB Workgroup has taken the lead in identifying opportunities to reduce emissions from residential wood burning.

Out-of-Service PCP Treated Wood

The Utility Solid Waste Activities Group (USWAG) has developed treated wood guidelines setting forth lifecycle management principles regarding the proper purchase, use, reuse, and disposal of treated wood. USWAG is committed to promoting these principles within the electric utility industry and has coordinated the development of the guidelines with USEPA. USWAG has also proposed to enter into a "Memorandum of Understanding" (MOU) with USEPA to further promote the principles set out in the guidelines regarding the environmentally sound management of treated wood products. The MOU is currently being reviewed by USEPA.

Potential releases from secondary uses of PCP-treated wood represent a potential opportunity for the GLBTS Dioxin Workgroup to reduce dioxins in the Great Lakes Basin. The workgroup would like to explore the opportunity of establishing a pilot promotion campaign to educate the public and industry on the proper use and handling of used treated wood to reduce the health and environmental impacts in the Great Lakes Basin. This may involve reviewing and updating existing Consumer Information Sheets, and promoting them by increasing their distribution and through other communications activities.

4.2.2 Opportunities to Help Characterize Unknown Sources

There are also opportunities for the GLBTS to help characterize sources of dioxin for which inventory estimates have not been made.

The GLBTS Dioxin Workgroup has developed draft issue papers for several sources of non-controlled combustion, including: agricultural burning, structure fires, tires fires, wildfires and prescribed burning, and landfill fires. The results of these papers will help the workgroup evaluate the potential impact of these sources on the Basin and focus priorities for addressing sources of non-controlled combustion.

The GLBTS Dioxin Workgroup is also gathering information on poorly characterized industry sources of dioxins, including: secondary metal smelting, coke production, ceramic manufacturing, foundries, asphalt mixing, petroleum refineries, and industrial boilers. This information will help the workgroup evaluate the potential impact of these sources on the Basin and focus priorities for addressing poorly characterized industry sources.

4.3 OTHER SUBSTANCE-RELATED OPPORTUNITIES FOR THE GLBTS

There may be additional opportunities for the GLBTS to reduce exposure to dioxins, facilitate tracking of dioxins in the environment, and improve understanding of the contribution of long-range sources.

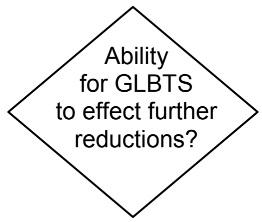
The GLBTS may have an opportunity to significantly impact exposure to dioxins through pathway intervention. Greater than 95 percent of exposure to dioxins occurs through the consumption of animal fats in the commercial food supply (e.g., meats, dairy products, fish and shellfish). Fish consumption is thought to make up about one-third of the total general population dioxin TEQ exposure. Only small amounts of exposure occur from breathing air, from inadvertent ingestion of soil containing dioxins, and from absorption through the skin contacting air, soil, or water (Dioxin Interagency Working Group, 2004). An opportunity may exist for the GLBTS Dioxin Workgroup to impact the dominant route of dioxin exposure by gathering information on dioxin levels in food, identifying major pathways of entry into food, and attempting to intervene in these pathways. Currently there are ongoing programs that affect pathway intervention such as fish advisories (for dioxin) and the Superfund program. The Dioxin Workgroup will continue to periodically review new information and to monitor whether there are opportunities for environmental programs that could significantly intervene in pathways of exposure.

Coplanar (dioxin-like) PCBs also partially account for general population dioxin TEQ exposure. An opportunity may also exist for the GLBTS to investigate the issue of coplanar PCBs in the Great Lakes Basin by compiling available information on sources and environmental data, and to coordinate efforts with the GLBTS PCB Workgroup to mitigate exposure from coplanar PCBs. An opportunity may also exist for the GLBTS to coordinate with the PCB task force related to reservoir sources.

While several programs monitor dioxins in the environment, a comparable set of monitoring data from the US and Canada would facilitate the tracking of progress with respect to levels of dioxins in the Great Lakes Basin. The GLBTS Dioxin Workgroup has begun to assess the compatibility of ambient air monitoring networks used in Canada (NAPS) and the US (NDAMN), as well as the Integrated Atmospheric Deposition Network (IADN), to achieve an integrated air monitoring network within the Great Lakes Basin. It is critical that both countries maintain their support of dioxin/furan monitoring in ambient air and other media.

Although there is a good understanding of domestic sources of dioxin/furan emissions in Canada and the US, there is currently insufficient information to characterize how sources outside of the Basin impact the Great Lakes Basin. Dioxin/furans are highly persistent substances that can be transported by prevailing winds and deposited in soils and sediments. Researchers at Lawrence Berkeley National Laboratory investigated the North American and global scale transfer efficiency of Level 1 substances to the Great Lakes using the Berkeley-Trent (BETR) contaminant fate modeling framework (MacLeod et al., 2005). The modeling results showed that continental scale emissions of dioxin can significantly impact the Great Lakes, but emissions within the Great Lakes region are responsible for the majority of dioxin deposited to the Lakes from the atmosphere. Additional long-range air modeling of dioxins/furans may provide a better understanding of the contribution from sources outside the Basin and help the workgroup prioritize sources and issues.

4.4 GLBTS OPPORTUNITY ASSESSMENT CONCLUSIONS



While significant reductions have been achieved in both Canada and the US, **a number of opportunities for further GLBTS action are identified** in Sections 4.2 and 4.3. Pursuing additional opportunities may be beneficial for the following reasons:

- Opportunities for joint workgroup collaboration would combine resources to impact multiple Level 1 substances;
- Estimates have not been developed for a number of poorly characterized sources, indicating that total releases of dioxins may be higher than previously thought;
- Further GLBTS actions would continue the momentum for reducing dioxins in the Great Lakes Basin; and
- Synergy with the B(a)P/HCB Workgroup as it relates to uncontrolled combustion.

Despite the opportunities and benefits identified, it is also important to consider the effectiveness of pursuing these activities under the GLBTS, such as engaging interested stakeholders, the level of input expected from workgroup members, resource availability under the GLBTS to conduct studies and programs, status or strategy of the US and Canadian national dioxin programs, and value-added of GLBTS efforts to the national dioxin programs in both countries.

5.0 MANAGEMENT OUTCOME

This section considers the environmental analysis presented in Section 3.0 and the GLBTS opportunity assessment presented in Section 4.0 to arrive at a final management outcome.

In consultation with the GLBTS Dioxin Workgroup, the recommended management outcome for dioxin is **continued active Level 1 status** with periodic reassessment by the GLBTS. Existing environmental data show that, although there is indication of a declining trend over the long term, dioxins and furans continue to exceed criteria in some media and to affect human exposure. Furthermore, with recent reductions in government resources for the national dioxin programs in both countries, maintaining the GLBTS Dioxin Workgroup would continue the momentum for reducing dioxin releases and for monitoring dioxin levels in the Great Lakes Basin. Most dioxin/furans sources are not lake specific and therefore management of these substances cannot appropriately be referred to the Lakewide Management Plans. The quantity of dioxin/furan release in both countries is continuously declining and it is not the workgroup's intention to chase the last molecule. However, it will work towards the goal of virtual elimination by continuing to gather and review new information, and to seek opportunities to prevent or reduce dioxin/furan release when feasible. The level of effort and frequency of meetings by the workgroup are expected to be reduced. It may be more beneficial to the Great Lakes Basin to divert GLBTS resources to address other emerging issues or substances within the Basin.

Significant reductions of dioxin/furan releases from major point sources have been achieved in the past decade. In the US, more than half of dioxin releases are now attributed to the open burning of household waste. In Canada, half of dioxin releases are attributed to open burning of household waste, motor vehicles, and nonferrous foundries. These remaining source types make it difficult to develop overall quantitative challenge goals. The Dioxin Workgroup may consider framing new qualitative challenge goals to develop programmatic targets such as "ensure each Great Lake State and Province has a strong burn barrel outreach program". The workgroup may also examine possible numerical targets for specific sources or priority sources identified in the future.

The greatest opportunity for the Dioxin Workgroup, through the Burn Barrel Subgroup, will be to continue its efforts to actively engage partners on the issue of household garbage burning and to educate public and local officials. Another comparable outreach opportunity is to establish a pilot education campaign on used treated wood. However, it is difficult to track quantitative emissions reductions for these sectors.

There is an opportunity to examine pathway intervention and to understand human exposure pathway dynamics. Identifying pathways and mechanisms through which dioxin enters the food supply would address the principal route of human exposure. This may require recruitment of new workgroup participants from food safety, public health, agricultural agencies, and perhaps state and local officials. Since the GLBTS focuses on source reduction of pollutants, the role of the Dioxin Workgroup would be to identify key pathways and intervention opportunities. The appropriate agencies and stakeholders would then be engaged to pass on this information and to encourage actions.

The Dioxin Workgroup will also work with other GLBTS workgroups and engage new members on common issues of concern such as uncontrolled combustion and coplanar PCBs. The workgroup will continue to track and gather information on poorly characterized sources of dioxin and to address sources that cannot be controlled through point source reduction activities (e.g., sediments and other historical sources). In working towards the goal of virtual elimination of dioxins and furans, the workgroup will continue to fill inventory gaps and seek source reduction where feasible. In addition, the workgroup will examine available regional modeling results and data on environmental media where criteria are exceeded or dioxin levels are elevated and identify potential sources to address, within and outside the Great Lakes Basin.

Challenges

Despite ongoing opportunities to seek source reductions of dioxins/furans in the Great Lakes Basin, there are important considerations for the workgroup to determine its effectiveness in accomplishing these activities. These considerations include:

<u>Engaging appropriate stakeholders to actively participate in the workgroup</u>
The issues identified above would require participants from States, Province, and officials from the agriculture and health sectors. There are also resource limitations for States and the Province to actively participate. It is important for the workgroup to prioritize the sources or issues to address and then engage the appropriate stakeholders to the workgroup. This may be done using the matrix established in 1999. It should be noted that the low quantity of source release and lack of regulatory backstop may pose a challenge to gain their interest in participating. Therefore, joint activities with other workgroups or existing programs may be necessary to engage participation. The Burn Barrel Subgroup has demonstrated its effectiveness in focusing on a specific issue under the Dioxin Workgroup. Additional issue-specific or sector-specific subgroups may be formed but would require participation by the appropriate stakeholders.

<u>Revisiting the frequency of in-person meetings</u>
Due to the resource constraints faced by government agencies and possibly other stakeholders, less frequency of traveling to face-to-face meetings may facilitate willingness to participate by the required stakeholders. To compensate for the meetings, the workgroup or subgroups may hold regular teleconference calls to report progress. Many of the outstanding sources such as household trash burning, diesel trucks, open burning, and sewage sludge are mainly the responsibility of the governments and should be dealt with through interaction among federal, States/Province and local governments. These issues are also more challenging to address, and significant reductions in the short term are not expected.

<u>Availability of resources to conduct studies or projects</u>
Source reduction studies or projects under the GLBTS have been achieved by a voluntary approach or existing programs underway. Financial support required to conduct any studies or projects is not allocated to the workgroup but is obtained through in-kind or financial contribution by members, mostly EC or USEPA. Members must seek funding by making requests through their individual organizations.

<u>Linking to national/international activities and goals</u>
Both countries have national programs and are involved with international protocols on dioxins/furans. Although there has been a reduction in resources to support the national programs, both countries are still committed to meet the international protocols (e.g., CEC-NARAP, UNEP-Stockholm Convention). The workgroup should work with these initiatives to share information and to ensure consistency.

Further discussions among the Dioxin Workgroup and guidance from the GLBTS Integration Workgroup are required in order to define the goals, structure, proposed workgroup membership, and level of future effort required.

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APPENDIX A

GENERAL FRAMEWORK TO ASSESS MANAGEMENT OF GLBTS LEVEL 1 SUBSTANCES: BACKGROUND, OBJECTIVES, AND DOCUMENTATION

BACKGROUND

Over the past thirty years, the governments of Canada and the United States have joined together with industries, citizen groups, and other stakeholders in a concerted effort to identify and eliminate threats to the health of the Great Lakes ecosystem resulting from the use and release of persistent toxic substances. A major step in this process was the enactment of the *Revised Great Lakes Water Quality Agreement (GLWQA) of 1978* which embraced, for the first time, a philosophy of "virtual elimination" of persistent toxic substances from the Great Lakes. In 1987, the GLWQA was amended, establishing Lakewide Management Plans (LaMPs) as a mechanism for identifying and eliminating any and all "critical pollutants" that pose risks to humans and aquatic life. In 1994, the International Joint Commission's *Seventh Biennial Report* under the GLWQA called for a coordinated binational strategy to "stop the input of persistent toxic substances into the Great Lakes environment." This led to the signing of the *Great Lakes Binational Toxics Strategy* (GLBTS, or Strategy) in 1997. The Strategy specifies Level 1 substances, each targeted for virtual elimination and each with its own specific challenge goals, along with Level 2 substances targeted for pollution prevention. The substances were selected on the basis of their previous nomination to lists relevant to the pollution of the Great Lakes Basin, and the final list was the result of agreement on the nomination from the two countries. The specific reduction challenges for each substance include individual challenge goals for each country, within a time frame that expires in 2006.

Significant progress has been made toward achieving the Strategy's challenge goals. As 2006 approaches, an analysis of progress and determination of next steps is needed to respond to the mandate set forth in the Strategy. The purpose in developing the *General Framework to Assess Management of GLBTS Level 1 Substances* is to provide a tool to assist the Parties (Environment Canada and US EPA) and stakeholders in conducting a transparent process to assess the Level 1 substances.

OBJECTIVE

The framework presents a logical flow diagram for evaluating progress and the need for further action by the GLBTS on the Level 1 substances in order to meet the following objective:

Evaluate the management of GLBTS Level 1 substances with the following potential outcomes:

1) **Active Level 1 Status & Periodic Reassessment by GLBTS**
2) **Consider Submission to BEC[2] for New Challenge Goals**
3) **Engage LaMP Process**
4) **Suspend GLBTS Workgroup Activities. Where warranted, refer to another program and/or participate in other fora. Periodic Reassessment by GLBTS, until Parties determine substance has been virtually eliminated.**

[2] The Binational Executive Committee (BEC) is charged with coordinating implementation of the binational aspects of the 1987 Great Lakes Water Quality Agreement, including the GLBTS. The BEC is co-chaired by EC and US EPA and includes representatives from the Great Lakes states and the Province of Ontario, as well as other federal agencies in Canada and the U.S.

Additional outcomes that may result from the framework are:

- **Recommend benchmark or criteria development as a high priority; and**
- **Recommend additional environmental monitoring as a high priority.**

The framework is intended to serve as a guide in determining the appropriate management outcome(s) for the Level 1 substances: mercury, polychlorinated biphenyls (PCBs), dioxins and furans, hexachlorobenzene (HCB), benzo(a)pyrene (B(a)P), octachlorostyrene (OCS), alkyl-lead, and five cancelled pesticides: chlordane, aldrin/dieldrin, DDT, mirex, and toxaphene. The framework is not intended to specify details of how a Level 1 substance should be addressed once a management outcome is determined.

STRUCTURE OF THE FRAMEWORK

The framework is set up in a hierarchical fashion to allow efficiencies in the decision process. The hierarchy of the framework is to first consider progress toward the challenge goals committed to in the Strategy, then to conduct an environmental analysis and finally, a GLBTS management assessment which leads to various potential management outcomes for a substance.

The environmental analysis (depicted in green) and the GLBTS management assessment (depicted in blue) comprise the two main parts of the framework. The environmental analysis considers available Canadian and U.S. monitoring data and established human health or ecological criteria as the primary basis for an objective evaluation of a substance's impact on the Basin. For substances lacking sufficient risk-based criteria or environmental monitoring data, the framework recommends the development of benchmarks or criteria and additional monitoring as a high priority. While the environmental analysis places emphasis on good monitoring data, evidence of use, release, exposure, or precautionary concerns may also be considered.

If the environmental analysis concludes that there is no basis for concern, GLBTS workgroup activities may be suspended, with periodic reassessment of the substance until the Parties determine that the substance has been virtually eliminated. If, on the other hand, the environmental analysis concludes that there is a reason for concern, the GLBTS management assessment evaluates the ability for the GLBTS to effect further improvements in and out of the Basin. The GLBTS management assessment also considers whether the impact of a substance is basinwide or restricted to a single lake. In cases where the GLBTS can effect further reductions, consideration will be given as to whether new Strategy challenge goals can be established. Virtual elimination is an underlying tenet of the Strategy and should be kept in mind throughout the assessment process.

The GLBTS management assessment can result in a number of potential management outcomes; the outcomes provided in the framework allow a substance to remain in active Level 1 status or GLBTS workgroup activities to be suspended. The outcomes also recognize that it may be appropriate to more actively involve a LaMP process, to refer a substance to another program, to represent GLBTS interests in other fora (e.g., international programs), or to consider proposing new challenge goals. All outcomes include a periodic reassessment by the GLBTS (approximately every two years).

While it is recognized that the Parties have an ongoing responsibility to promote GLBTS interests in other arenas, a potential outcome of the framework is to recommend referral to another program and/or GLBTS representation in other fora. In the GLBTS framework, this option is presented when there is no evidence of Basin effects, or when the GLBTS cannot effect further significant reductions on its own, but can advocate substance reductions in other programs and in international fora.

It should be noted that, in using the framework to conduct assessments for the Level 1 substances, it may not be possible to definitively answer “YES” or “NO” to all questions. It is not necessary to have a definitive answer to proceed in the framework. For example, in assessing whether there is environmental or health data to assess the impact of the substance in the Basin, it may be determined that, while additional data would be helpful, there is some data on releases and environmental presence in certain media with which to assess the status of the substance. In this case, judgment is needed to decide whether these data are sufficient to proceed along the “YES” arrow or whether the available data are not adequate and the analysis should proceed along the “NO” arrow, placing the substance on a high priority list for monitoring. As a general guide, the framework allows flexibility and judgment in interpreting environmental data and in determining the most appropriate management outcome(s).

Each decision node, or shape, in the framework is illustrated below along with a brief explanation that describes, in further detail, the question to be assessed.

GLBTS Level 1 Substances

Have the challenge goals for the substance been met?

All 12 Level 1 substances will be assessed.

The first question to consider in assessing the GLBTS status and future management of a Level 1 substance is whether the challenge goals agreed to in the Strategy have been met. The answer to this question informs the subsequent assessment in many ways, not only indicating progress, but also revealing issues associated with the ability to pursue further reductions. Progress toward the U.S. and Canadian goals will be considered jointly. Challenge goals will be evaluated with the best data presently available. Note that some challenge goals target "releases" of a substance while others target its "use". As a result, different types of data may be required to evaluate challenge goal status (e.g., "use" data vs. environmental "release" data). The framework continues with both the environmental analysis and GLBTS management assessment, notwithstanding the status of the challenge goals.

ENVIRONMENTAL ANALYSIS

Do we have environmental or health data to assess the impact of the substance in the Basin?

Characteristics of acceptable monitoring data to assess the temporal, spatial, and population representativeness of a substance in the Great Lakes Basin ecosystem include (but are not limited to) basin-specific measures in water, air, sediment, soil, indoor environments (e.g., dust), fish, biota, or human biological samples. If necessary, use or release data may be used as surrogates (e.g., in the case of alkyl-lead).

High Priority for Monitoring

"What gets measured gets managed." Substances entering this box will be recommended as a high priority for monitoring to the Parties. The intent is that these GLBTS substances will be considered by a wide range of government or private agencies when they make decisions regarding which analytes to monitor in the environment. As sufficient monitoring data is developed, substances will be re-evaluated.

Have sufficient risk-based criteria been established (e.g., GLI or other)?

Relevant criteria include, but are not limited to:

- Water quality criteria
- Fish tissue concentrations
- Ambient or indoor air standards
- Sediment or soil standards
- Limits based on reference doses
- Health-based standards for human biota measurements

High Priority for Benchmark or Criteria Development

If there are no criteria against which to evaluate current levels, the GLBTS will consider whether there is a need for the Parties to recommend the development of human health or ecological criteria. This box effectively creates a GLBTS list of substances that are in need of human health or ecological criteria with which to identify exceedances in the environment.

Do levels in biota, air, water, etc. exceed criteria?

As the framework is intended to be flexible in its implementation, the choice of criteria to use in answering this question may vary. For example, the most strict criteria in one or more media may be used to evaluate environmental levels.

Is the trend decreasing?

If there are no criteria, or if current levels do not exceed criteria, this box considers whether there is a decreasing trend. A decreasing trend could be defined as a statistically significant negative slope. If the trend is decreasing, the substance is evaluated for evidence of concern based on use, release, exposure, or the precautionary approach. If a decreasing trend cannot be established, then the substance moves directly to the GLBTS management assessment to determine the ability of the GLBTS to effect further reductions.

* Note that, in the event that there are established criteria and the GLBTS substance is below those criteria but not decreasing in trend, further analyses may be required to estimate when criteria might be exceeded.

Is there a reason for concern based on use/release/ exposure data or the precautionary approach?

In cases where sufficient monitoring data is not available, or where environmental trends are decreasing and criteria have either not been established or are not being exceeded, the relevant question is whether there is evidence of Basin effects based on documented use, release, or exposure data, or from a precautionary point of view. An example of a precautionary point of view would be documented evidence of significant impact in another geographic location with the same sources and use patterns as in the Basin, or because the effects of a pollutant would be significant by the time it was able to be measured through monitoring.

GLBTS MANAGEMENT ASSESSMENT

Ability for GLBTS to effect further reductions?

Answering this question involves an accelerated version of the first three steps of the GLBTS 4-step process,[3] looking at sources and current programs and regulations to see where the reduction opportunities lie. Part of the assessment will involve consideration of whether the reduction opportunities will be significant enough to merit the effort.

Principally lake specific?

Based on a joint GLBTS-LaMP determination that the impact of a substance is restricted to a single lake, the appropriate LaMP will be engaged for coordination of leadership for reduction actions to be undertaken by the responsible organizations.

Can new challenge goals be established?

The GLBTS will assess the practicality of setting forth new challenge goals.

[3] The GLBTS four-step process to work toward virtual elimination is: 1) Information gathering; 2) Analyze current regulations, initiatives, and programs which manage or control substances; 3) Identify cost-effective options to achieve further reductions; and 4) Implement actions to work toward the goal of virtual elimination.

GLBTS MANAGEMENT OUTCOMES

Active Level 1 Status & Periodic Reassessment by GLBTS

The substance will continue as a Level 1 with reduction actions addressed by the appropriate process and with periodic reassessment, approximately every two years, using the *General Framework to Assess Management of GLBTS Level 1 Substances*.

Consider Submission to BEC for New Challenge Goals

The GLBTS will consider recommending new challenge goals to BEC. The justification for new challenge goals will incorporate the findings of the framework analysis and will include assessment of the desired environmental improvement and feasibility. If the GLBTS decides to propose new challenge goals, the recommendation to BEC will include a reduction percentage, reduction timeline, and baseline for the proposed new challenge goals.

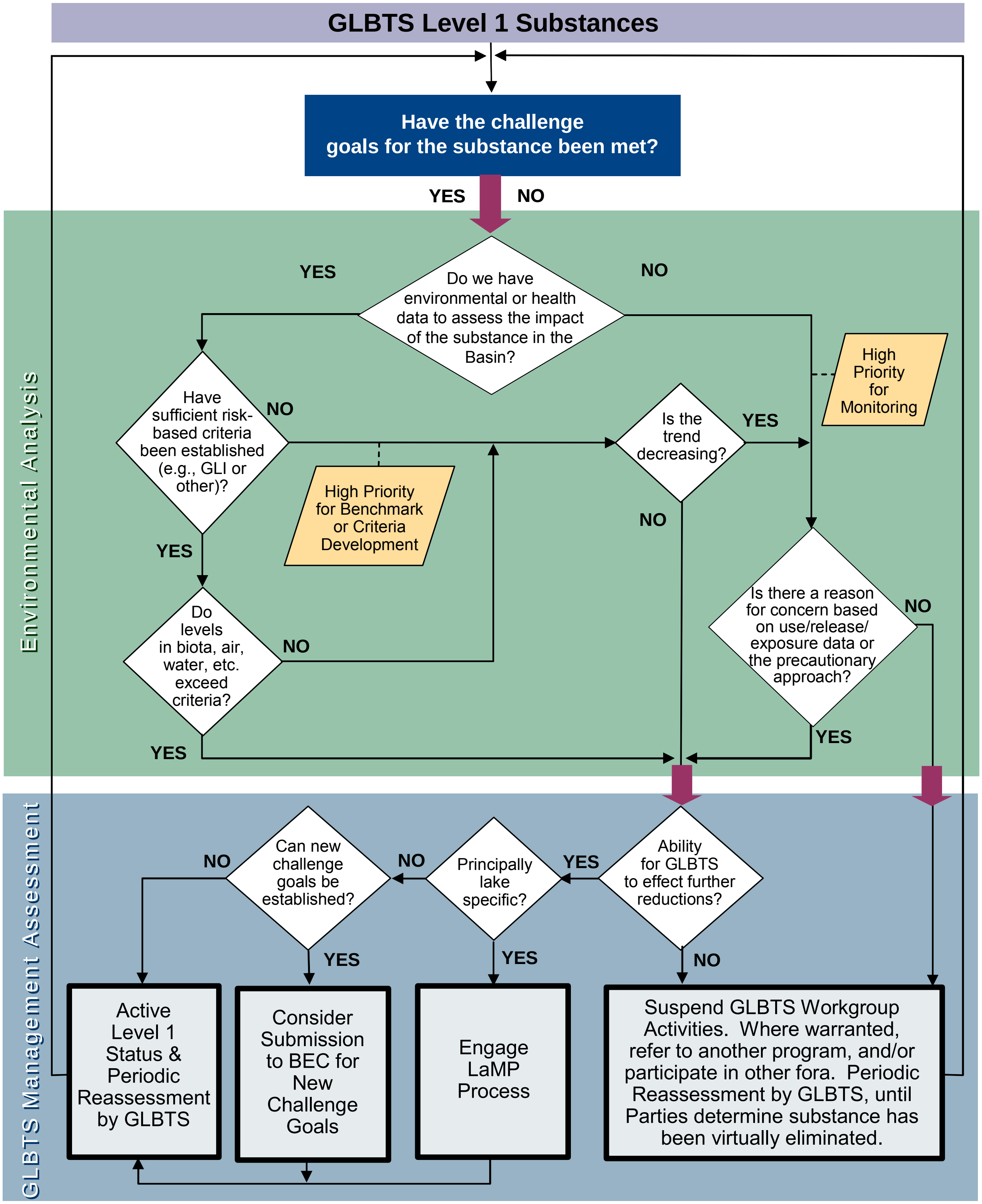
Engage LaMP Process

For substances whose impact is lake-specific, the appropriate LaMP will be engaged to coordinate substance reduction activities with continued support from the GLBTS, recognizing the limited direct implementation capacity of the LaMPs. It is understood that much of the actual implementation would be carried out by the agencies with responsibility to address these substances. A joint review of progress would be undertaken periodically.

Suspend GLBTS Workgroup Activities. Where warranted, refer to another program, and/or participate in other fora. Periodic Reassessment by GLBTS, until Parties determine substance has been virtually eliminated.

In the event that the GLBTS is not able to effect further reductions, or there is no evidence of Basin effects, GLBTS workgroup activities will be suspended. Where warranted, a recommendation will be made to a) refer reduction efforts for the substance to another program, and/or b) represent GLBTS interests in other fora (e.g., Commission for Environmental Cooperation, United Nations Environment Programme). There will be no ongoing workgroup involvement with these substances, though each one will undergo periodic reassessment, approximately every two years, using the *General Framework to Assess Management of GLBTS Level 1 Substances*, until the Parties determine that virtual elimination has been reached.

General Framework to Assess Management of GLBTS Level 1 Substances



APPENDIX B

ENVIRONMENTAL/HEALTH DATA

B.1 SAMPLING AND ANALYTICAL METHODOLOGY FOR SCREENING LEVEL SURVEY OF SEDIMENT QUALITY IN TRIBUTARIES TO THE LOWER GREAT LAKES

Figure B-1 shows the tributaries sampled in the surveys conducted in the lower Great Lakes for the 2001-2003 period. Surficial (top 1-2 cm) sediments were collected from one or more depositional reaches of each tributary, upstream of its mouth, using either a stainless steel spoon (shallow water depth, low current) or a petite Ponar Grab sampler. The sampling program was based on the Guidelines for Collecting and Processing Samples of Stream Bed Sediment for Analysis of Trace Elements and Organic Contaminants, developed by the United States Geological Survey for the US National Water-Quality Assessment Program (Sheldon and Capel, 1994). Sites represented different in-stream locations (e.g., pools, different depths of water, behind dams). Samples from all sites were composited, sieved and further homogenized and then collected into 250 ml glass jars with Teflon-lined screw caps for organochlorine (OC) and polyaromatic hydrocarbon (PAH) analyses. Samples for metal analysis were collected into 125 ml polyethylene jars. Organics were analyzed by Maxxam Analytics Inc. After accelerated solvent extraction, OCs were analyzed by gas chromatography/dual column electron capture (GC/ECD). PAH samples were extracted by sonication, the extracts concentrated, and analyzed by GC/MS. Results are reported on a dry weight basis. Caduceon Environmental Laboratories (Ottawa, ON) performed the metal analysis (including mercury) on freeze dried samples using *aqua regia* digestion. Details are provided in Dove *et al.* 2002. Analyses for dioxins and furans at selected sites were carried out by the Ontario MOE. Samples were extracted and analyzed by HR GC/MS.

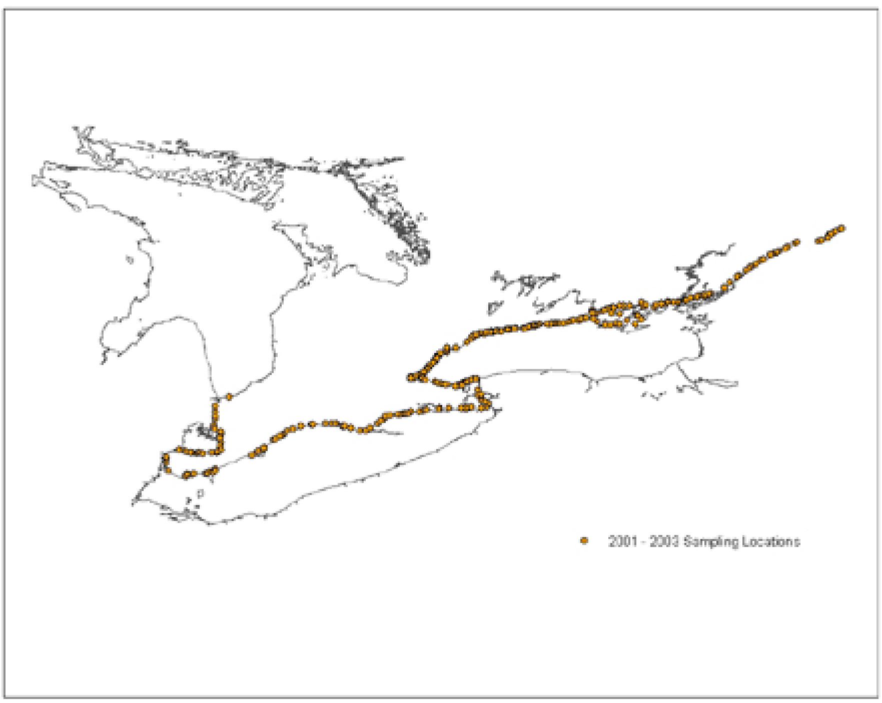


Figure B-1. Surficial Sediment Sampling Locations for the Lower Great Lakes

B.2 ST. CLAIR-DETROIT RIVER CORRIDOR – UPSTREAM/DOWNSTREAM WATER QUALITY MONITORING

Objectives and Monitoring Strategy

A whole-water monitoring program for the St. Clair and Detroit Rivers was initiated, in 2001, to assess a wide range of organic and inorganic contaminants. This monitoring effort is a component of Environment Canada's Great Lakes Surveillance and Connecting Channels program and supports Remedial Action Plans (RAPs) for the restoration of beneficial uses of the St. Clair and Detroit Rivers and Lakewide Management Plans (LAMPs) for Lake Erie. The intent is to identify contaminants of concern and to characterize their concentrations with a primary focus on upstream-downstream differences in concentration, compliance with relevant water quality guidelines, values, criteria, and/or objectives, and, where applicable, to provide supporting data to assess the effectiveness of remedial actions and to determine whether improvements in water quality are being achieved.

The monitoring strategy adopted was to select a reference site for each river that was in the main headwater channel, upstream of all riverine inputs. The downstream sampling sites, which are intended to track and be responsive to changing toxic contaminant concentrations, are located below of all major contaminant inputs, in nearshore channels, off the east and west shores of the St. Clair and Detroit Rivers. This has been an effective strategy.

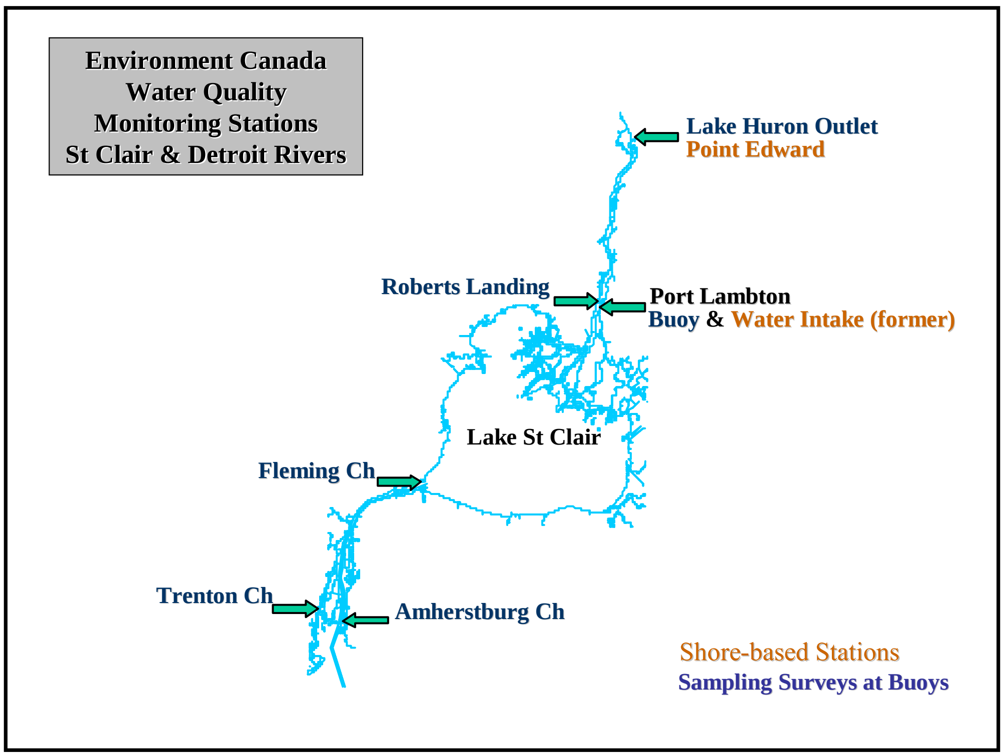


Figure B-2. Water Quality Monitoring Locations in the St. Clair - Detroit River Corridor

In order to realize the goal of providing valid riverine data several the following approaches has been adopted. Clean field techniques are being used and, thus, issues of relating to sample contamination have been effectively mitigated. Collection of large volume samples (150) has provided a capability for ultra low level analyses, for a wide range of contaminants. Therefore, assessing the data against the most sensitive guidelines is being achieved. Back-up samplers are deployed at each site to ensure that samples are being collected. Combined, the data collection objectives are being met.

Methods

Samples for organic contaminant analyses are collected with submersible samplers that have an internal computer-controlled pump/flow metering system that allows the operator to set the desired sample process rate and total volume to be sampled. Sample water contact with the instruments pump and flow metering systems occurs after processing, and therefore, risks of sample contamination are mitigated. The suspended sediment fraction is collected on stacked filter sets consisting of 3 μm and 0.7 μm glass fibre filters, whereas contaminants associated with the aqueous phase or filtrate are adsorbed onto XAD-2 resin. Sample water is drawn at modest flow rates (100 to 150 $mL \cdot min^{-1}$) through the filter sets and then through the column, which contained 85 mL of XAD-2 resin. The resulting bed load flow rate factor is less than 2, and thus, the extraction efficiency is optimized. A total sample volume of 150 L was established to provide sufficient sample for the required analyses and to mitigate the risk analyte breakthrough.

B.3 NATIONAL AIR POLLUTION SURVEILLANCE NETWORK (NAPS)

For the COA substances sampling program, PCDD/PCDF samples are normally collected every 24 days, but more frequent sampling was employed at some sites during some years. Additional information on sampling and analytical methods is available in previous reports (Brook et al. 1997; Dann 1998; Dann 1999). Figure B-3 presents the locations of monitoring sites in Ontario. For PCDD/PCDF, samples are collected using a high-volume filter/polyurethane foam. Analysis is performed by high resolution gas chromatography and high resolution mass spectrometry with a detection level of 1-20 fg/m^3 (Environment Canada, 2004b).

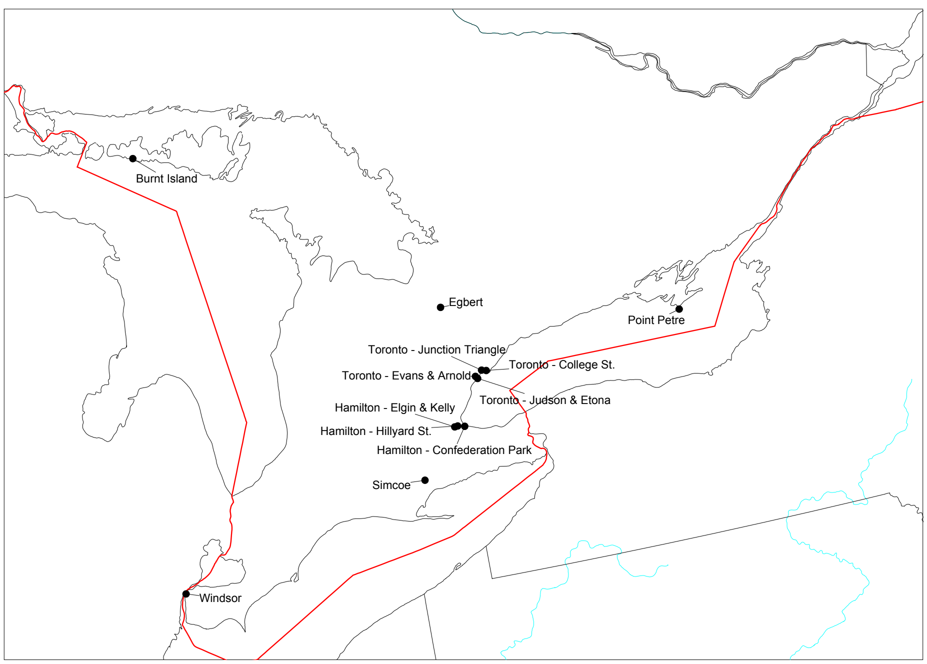


Figure B-3. Monitoring Locations in COA Substances Sampling Program